Hunter's handbook of Victoria bridge

R. Bell.

HUNTER'S HAND BOOK OF VICTORIA BRIDGE

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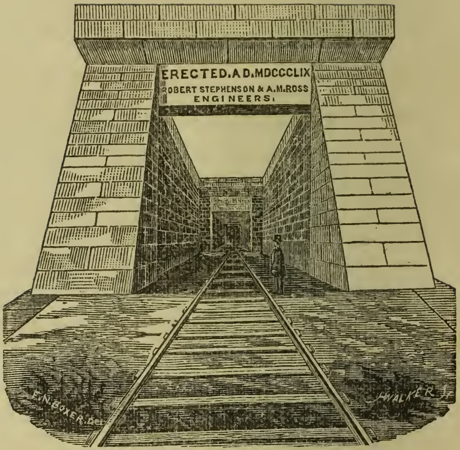
MONTREAL, C.E.

HUNTER'S HAND BOOK

OF

THE VICTORIA BRIDGE.



ENTRANCE TO THE VICTORIA BRIDGE.

The inscription on the lintel over the entrance to the abu ment is shewn in the above wood-cut; and on the lintel over t entrance to the tube is inscribed,—

BUILT

BY

JAMES HODGES,

FOR

SIR SAMUEL MORTON PETO, BART.,

THOMAS BRASSEY, AND EDWARD LADD BETTS,

CONTRACTORS.

HUNTER'S HAND BOOK

OF THE

VICTORIA BRIDGE,

ILLUSTRATED WITH WOOD-CUTS:

A Brief History of that wonderful Work, from the time that the first practical idea for its construction was submitted to the Public in 1846, up to its completion in 1859.

ALSO,

A SHORT SKETCH OF THE LIVES

OF THE

CELEBRATED STEPHENSONS.

"Now we can form an estimate of the value of those *few acres of snow* eded to England with such culpable carelessness by the Government of ouis XV."—*Count Jaubert at the Paris Universal Exhibition in* 1855.

BY F. N. BOXER,

ARCHITECT AND CIVIL ENGINEER.

Dedicated (by permission) to the Grand Trunk Railway of Canada.

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CONTENTS.

PREFACE.

In endeavouring to place before the reader a short, but faithful, history of the Victoria Bridge, from the time that the first practicable idea for its construction was brought before the public in 1846, up to its complete realization in 1859, the writer of these pages has sought for no information but such as he could obtain from authentic sources; and, however imperfectly the facts obtained have been compiled, he trusts that the work will be entitled to, at least, the merit of being considered a faithful record of the ways and means by which the noblest river in the world has been spanned by the noblest bridge.

DEDICATION.

The Publishers, in dedicating this volume to the President, Directors, and Manager of the Grand Trunk Railway Company of Canada, under the favor of their permission, trust that its contents will be found to be a faithful record of events connected with its history which occurred before and during the construction of the Victoria Bridge. They have endeavored to obtain an impartial statement of facts from authentic documents, and have recorded them in its pages with feelings totally unprejudiced towards any party.

In putting together the facts connected with its history, one cannot but read with wonder of the rapid strides which this noble colony has made in civilization and in wealth, as well as in general progress in Agriculture, Manufactures, Arts, and Sciences, since the construction of its great railways, which have been truly said, to be the arteries and veins of the body politic, through which flow the agricultural productions and the commercial supplies which are the life-blood of a state ; and one feels that if such has been the rapid progress of Canada, during the infancy of her days, from the construction of the Grand Trunk Railway, what will be the profit of that Railway when, in maturer years, all her resources are developed ?

HUNTER'S HAND BOOK

OF

THE VICTORIA BRIDGE.

CANADA, "the brightest jewel in the British Crown," and gifted by nature so bounteously with great natural advantages; Canada,—now so justly proud of her prosperity, because that prosperity has been nobly earned by the energy and industry of an intellectual race,—but a quarter of a century past, was not considered by other nations as a commercial country, and but little known, we regret to say, to the mother country herself, except as a mere timber depôt, a large unprofitable waste, a drain upon her resources. But the elements for making Canada a great and powerful country existed among her people and in her soil, which required but some motive power to call them into action; and at the London and Paris Exhibitions, in 1851 and 1855, she took her place among the producing nations of the earth, and has since surpassed them all in the magnitude of an undertaking which now strides across our unrivalled river—a monument of engineering skill—a noble testimony of the energy and perseverance of her people—and a type of the character of the present Canadian race.

In 1759, the brave Wolfe and Montcalm fell fighting at the head of their respective armies in a deadly struggle for this Province, which, in 1760, was surrendered to the English nation; and at that time, the whole population of

the country, from east to west, did not exceed 70,00(souls.

In August, 1860—just 100 years after—we look for ward with hope to behold the child of our belovec Sovereign, the heir of England's throne. He come among us that he may behold this rich and flourish ing Colony, to mingle with its industrious and happy people,—a race of whom England may well be proud; no men whose wealth has descended to them from one genera tion to another, nor who have gained their positions ii life by the aid of powerful connections or influential friends but men who have raised this Colony to its present positioi among nations by the general energy of their characters the industry of their habits, their morality and order. I such a people constituted the inhabitants of some of th states of Europe, over which the rays of science hav beamed for centuries—when on this country its light ha only begun to dawn—that country would speedily becom a first-rate power; and it requires but little of the spiri of prophecy to foretell that, if we are but true to ourselves our destiny is a great one; what we have already show to the world is but the shadow of our future greatness.

Canada is a country of unlimited resources, rich in soi and in minerals; her forests alone are a mine of wealth and her rivers and inland seas abound with fish. Thes resources which are gradually becoming more developec through the easy means of transport afforded by our rail ways and canals, will ever be a source of a large revenue tc her exchequer; and if her progress continues in ratio with her advancement during the last ten years, she will not only be known as the brightest gem in England's Crown, but will prove a faithful friend in the days of peace—a powerful ally in a *day of need.*

In 1808 not a steamer floated on the bosom of the St.

Lawrence; now hundreds rush along its waters on one uninterrupted inland navigation nearly 2000 miles in length.

In 1840, a small railroad, the only one in either Province, was that from Laprairie to St. Johns, 14 miles in length, and connecting Lake Champlain and the St. Lawrence: it was looked upon with admiration and wonder. Now, 1200 miles of railway intersect this Province in one continued line from Port Sarnia, on the shores of Lake Huron, to Rivière du Loup, near the mouth of the St. Lawrence, and, altogether, nearly 2000 miles of railroad, in different directions, have opened up the country to commerce. But thirteen years ago heavy goods had to be transported over almost impassable roads at an enormous cost and loss of time; now splendid canals connect river and lake in, almost, one continued chain of uninterrupted navigation.

In 1842, it took days for a letter to reach a distant part of the Province; at present, telegram wires, like spiders' threads, extend from city to city and the thoughts of man fly with lightning speed. The voice of our Queen has already passed under the waters of ocean in friendly greeting to a ruler of a powerful country; and we hope, with that prophetic hope which falls upon us like a forerunner of certainty, that the day is not far distant when the words of our beloved Sovereign will again pass under the great Atlantic, and bring greetings of peace, good will and gladness to her loyal subjects in Canada.

And such are the changes which have come over this Province within the short period of a quarter of a century, in which her struggles to keep pace with other countries in the rapid strides of improvement have been of no ordinary kind. There is nothing that proves more prejudicial to public undertakings than popular and false prejudices; and too frequently do we find statesmen and influential persons biassed in their opinions and judgments.

There exists, also, in every community, a certain class of people who are always ready to decry the praiseworthy projects of others, and who can view no public undertaking without attributing to its projectors selfish and sordid views; who, when success has crowned the persevering efforts of a talented man, are ready, like harpies, to snatch from him the meed of praise by attributing the glory of the work to other people.

It might be considered out of place in a work of this kind, professing to give merely a history of the bridge, to enter into any reflections of the foregoing nature, but it is our desire to place before the public, in a true light, the names of those persons to whom "Canada and the world are indebted for the Victoria Bridge," from the construction of which a new era in the commercial prosperity of this country is likely to ensue.

We also purpose to record the names of all those who were particularly employed on the work; and we would beg to remark, that in so doing, the information afforded is not from mere *hearsay*, but from a diligent and careful examination of documents, the authenticity of which is undisputed.

It has been stated that, some years ago, the idea of crossing the St. Lawrence, either by bridge or tunnel, had occurred to the imagination of some of the citizens of Montreal; in this there was nothing extraordinary, for such an idea is but a simple thought that would rise up in the mind of any ordinary man, who wished to send or bring goods across the river at a time when it was impassable from floating ice; and some very visionary schemes are said to have floated in the brains of more than one individual in this city. But to the mind of the great Stephenson, when he first visited this country, some twenty-seven years ago, "the idea of bridging the St. Lawrence

never occurred;" simply, we suppose, because he possessed no property on either shore that would have been improved by its construction in any particular spot, and then he, probably, would have wished, like other men, to have crossed the river—but by a feasible plan.

In June, 1846, an editorial appeared in the *Economist*, a paper then published in Montreal, of which the following is an extract. It was written at a time when a great difference of opinion existed as to the proper site for the terminus of the Atlantic and St. Lawrence Railway:

"But where is the terminus of the St. Lawrence railway to be? Let us examine the advantages of the several points that present themselves for the terminus; if it is made at Longueuil, or if it is placed immediately opposite the city, a little above St. Helen's Island, long solid wharfs, (owing to the shallowness of the water,) will have to be built to enable freight cars to reach vessels coming from the interior. Ferry boats will be required to convey passengers across the river, and a natural consequence must be, that a great portion of the business will be done on the opposite shore. But a still greater objection is, that at the very time we most require a railroad to carry off what produce may be left on board for shipment, all communication is closed—we mean in the spring and fall. How, then, is the difficulty to be got over? We reply, by building a bridge across the St. Lawrence. This is no visionary scheme; we speak advisedly when we say that it is *perfectly practicable*. Such a bridge should be erected from this side, a little below Nun's Island, at which part of the river the water is quite shallow, and the shoving is nothing like so violent as lower down the river."

This article was written by the Hon. John Young; and it is worthy of remark how excellent are the perceptive faculties of this energetic citizen, that the bridge has actually been constructed on, or near, the line indicated by him in the above extract.

In September of the same year, another article appeared

in the *Economist*, written by the same gentleman, in which he stated:

"Twenty years ago, the project of a bridge across the St. Lawrence would have been scouted as absurd and impracticable, nay, twenty months ago there were few, even amongst our most energetic and enterprising citizens, who bestowed a thought on the subject. The opinion is daily gaining ground that the project is not only feasible, but highly expedient for the interests of the city."

In consequence of these remarks, action was at length taken in the matter.

On the 23d September, 1846, the following resolution was passed at a meeting of the Directors of the Atlantic and St. Lawrence Railroad Company:

"It was moved by Mr. Young, seconded by Mr. Galt, 'That this Board do hereby authorize the Company's Chief Engineer to cause a survey to be made of the proposed bridge across the St. Lawrence, for the purpose of ascertaining its practicability and an approximate estimate thereof."

The first survey ever made for the site of the Bridge was by Mr. A. C. Morton, then Chief Engineer of the St. Lawrence and Atlantic Railroad, in accordance with the instructions furnished to him by the Hon. John Young. This gentleman reported on the practicability of constructing a bridge across the St. Lawrence from below Nun's Island, in the general direction of the "Tobacco House," which is nearly the line of its present site; and Mr. Gay, in his report to the Hon. John Young, Chairman of the Committee for procuring plans, estimates, &c., for a bridge across the St. Lawrence at Montreal, thus alludes to this survey:

"Another line has been examined across the river, under the direction of Mr. Morton, Chief Engineer of the Atlantic and St. Lawrence Railway, to whose kindness I am under obligations for a copy of the soundings taken upon it, which is the

more valuable as affording comparative evidence of the accuracy of our measurements."

It does not appear that Mr. Morton's report was ever published, but his plan still exists in the Grand Trunk Railway Office, and is deposited among those connected with the St. Lawrence and Atlantic Railroad Company, before it became a part of the Grand Trunk Railway. The credit, therefore, would appear to be due to Mr. Morton as having been the first Engineer who, after a survey of the river, reported favourably on the practicability of constructing a bridge across the St. Lawrence, near its present site, according to the views of Mr. Young.

In October, 1846, Mr. Gay, of Pennsylvania, was employed by a committee of citizens, consisting of Messrs. Davidson, Bourret, Hayes, Pierce, Stephens, Young, and Judah. Of this Committee, the Hon. John Young was Chairman.

Mr. Gay, who was then Chief Engineer of the St. Lawrence and Atlantic Railway, likewise reported on the practicability of constructing a bridge over the river, but he condemned what was called the "railway line," not as impracticable, but because he considered preferable (for reasons given in his Report) a line extending "from a point half a mile above the foot of the island (Nun's), across the main channel to the house occupied by Charles Mayo," on the south shore of the river. There has existed an erroneous impression that Mr. Gay reported altogether unfavourably on the practicability of constructing a bridge across the St. Lawrence. This is an error, for in his Report he distinctly states:—"I am of opinion that a permanent and substantial bridge can be built, without encountering any difficulty of a serious character." The description of structure proposed by this Engineer, was "Burr's combined truss and arch bridge."

About this time a period of general depression seems to have prevailed throughout the Province. We quote the words of an article which appeared in the Toronto *Leader* on this subject, and from which we will take the liberty of drawing largely in these pages, as the statistics contained therein were obtained from the first authority.

"Five years, however, passed away, an epoch of social and commercial depression, and of political agitation, marked by the one melancholy feature of a continual struggle for the majority even to live. What energy, Montreal, as a commercial community possessed, was absorbed in the effort to finish the railway, and out of Montreal, the bridge was not looked upon with favour."

Still the bridge was not lost sight of: on the contrary, Mr. Young seldom failed, at the annual meetings of the St. Lawrence and Atlantic Railway Company, to point out its imperative necessity. It was not, however, till June, 1851, that the Directors of the above Company of which Mr. Young was one, furnished Mr. Thos. C. Keefer, C. E., with instructions to make a survey of the bridge. Mr. Keefer had been employed by the Montreal and Kingston Railway Company, of which Mr. Young was President, to make a survey of a line of railway from Montreal to Kingston, and it was at Mr. Young's earnest request to the Directors of the above Company, that the survey of the Bridge was included. It is worthy of being recorded in these pages, that Mr. Young overcame the great obstacle to Mr. Keefer's survey of the Bridge, by becoming responsible for the sum of £1500, advanced by the St.Lawrence and Atlantic Railway Company. This sum however, was insufficient, and the Harbour Commissioners advanced £150 as well, on Mr. Young's *personal guarantee*. The amount due to the St. Lawrence Railroad, was paid by the Grand Trunk Railway Company after the pass-

ng of the Bill; and the amount due to the Harbour Commissioners, with the advances made by Mr. Young out of his *private funds*, amounting to upwards of £600, were paid by the Grand Trunk Railway Company, about three years ago, under the authority of an Act of Parliament, which provided for the payment of all just claims against the St. Lawrence and Atlantic Railway Company.

It is seldom, indeed, that we meet with such liberality, in this country, on the part of a private individual to forward public purposes; and this, alone, shews the confidence Mr. Young possessed in the scheme, and entitles him, with what has been already stated, to the honour of having been the first projector of the Victoria Bridge.

In September, 1852, Mr. Young, then acting as Chief Commissioner of Public Works, suggested to the Hon. L. H. Holton, then President of the Montreal and Kingston Railway Company, the propriety of that Company waiving their charter, upon condition that the Grand Trunk Company would construct the Victoria Bridge. This was done in a letter dated 16th September, 1852.

The result of Mr. Keefer's survey is contained in a very ably written Report, which was afterwards published in 1853; and in justice to that gentleman, we cannot refrain from laying before the reader a few short extracts.

Mr. Keefer, in commencing the survey, at once saw the necessity of a thorough hydrographic survey of the shoals opposite to Montreal; which was very precisely made on the ice. The result of these soundings, Mr. Keefer states, "has fully confirmed my anticipations with respect to the peculiar conformation of the bed of the St. Lawrence opposite to Montreal, and its remarkable adaptation for a bridge site." He then proceeds to state that the bridge must be so arranged as not to impede the navigation, that a draw-bridge in its centre of 200 feet in width was im-

practicable, and recommended the adoption of a high leve bridge, elevated about 45 ft. over low water mark at th abutments, and rising gradually, from either shore, to th height required for steamers to pass under its main arch which was to span the navigable channel. The bays, o distances between the piers, on account of the crib which were to be placed around them as ice breakers, h fixed at 250 feet, and recommended the importance o solid approaches upon the shoals at either end of th bridge (as at present constructed).

"Having stated, first, that the bridge should pass over th navigation—second, that it should be a solid railroad bridg resting upon piers, and, thirdly, that these piers should be a few in number as practicable, I will add that it is greatly to b desired that so extensive and important a structure should b constructed of some more durable and less inflammable a mate rial than wood; the length of the superstructure required i about 7000 feet, the cost of which, if constructed of iron, woul be about six times greater per lineal foot than that built o wood."

"The extra cost of iron over wood would be about £500,00(or much more than the whole estimate for a wooden bridge. A wooden bridge properly constructed and protected will last hal a century, and if it were not for the contingency of fire, woul be all that is needed."

The difficulty of obtaining money for public works a this time—even for the means required to carry on thi survey—may have influenced Mr. Keefer's mind in mak ing this Report, as economy in every shape had to b consulted—for, in another part of Mr. Keefer's Report he says:—

"The cost of bridging the St. Lawrence from Point St. Charle across Moffatt's Island to the St. Lambert shore, will of cours depend upon the plan and material employed; but as the finan cial obstacles have hitherto been the barrier to its commence ment, it is necessary to present estimates, showing the leas

amount for which a serviceable structure can be obtained, as well as estimates for a complete and durable work worthy of the great interests which it affects." Again; "Recognizing the principle that it is the duty of an engineer to shape his plans according to the wants and necessities of the case, it will be evident that the class of structure undertaken will be governed by the prospective revenue.

"The cost of an effective bridge upon the site proposed, with a superstructure of wood for the arches, and a wrought iron tube for the centre one, the whole resting upon abutments and piers of substantial masonry, and having approaches formed by solid embankments of earth, will be £400,000 currency. With an iron superstructure in side arches, the cost would be £900,000 currency."

From the above extract we might infer that Mr. Keefer would have recommended a superstructure entirely of iron, could he have foreseen the amount of funds that were obtained a few years afterwards for this great object. As it was, he recommended a tubular beam of iron for the centre opening, at an additional cost of £43,000.

This Report of Mr. Keefer's, which embodied all the information obtained by the two previous surveys, entered very minutely into the local phenomena of the piling of the ice, and the possibility of overcoming the physical difficulties to be encountered, and was of great service to Mr. Stephenson, who, in making allusion to a portion of the work says:—

"I cannot do better than quote the following words from the excellent report addressed to the Hon. John Young by Mr. T. C. Keefer, whose experience in such matters, from long residence in the country, entitles his opinions, as to the proper character of such works, to confidence."

It would be out of place here, to enter into the differences and difficulties that occurred before the great railway contract ultimately fell into the hands of one great firm.

In October, 1852, the Grand Trunk Railway Company

made their first location surveys for the bridge; and in February, 1853, the survey for the bridge, on its present site, was commenced.

As we have already given notice to the names of those Engineers who were connected with the preliminary surveys and designs, we feel bound to say a few words in relation to Mr. Ross's claims in regard to the *great work;* for it is much to be regretted that any unpleasant feeling of distrust and jealousy should have arisen between Mr. Ross and Mr. G. R. Stephenson, the relative of Mr. Robert Stephenson, at a time when that colossus of science—that great and good man—was passing from this life to his God.

It would appear, from all that we can ascertain on this subject, from which we have made our own deduction, and the reader has the facts before him to make his therefrom, that when Mr. Ross visited this country in 1852, Mr. Young, who never for a moment abated in his zeal to see the accomplishment of his wishes fulfilled, took Mr. Ross with him in a boat, accompanied by a third person, to examine the different localities which had been recommended for a site of a bridge by the Engineers before mentioned; and after spending some hours upon the water in a careful examination, Mr. Ross was of opinion that the present site was the one he would select, and strongly advocated the construction of an iron tubular bridge. It is thought that before Mr. Ross returned to England he prepared a design of a bridge.

That Mr. Ross put his ideas into form, and is entitled to the credit of having submitted a design for a tubular bridge across the St. Lawrence is very probable, although Mr. Stephenson does not allude to it. Mr. Stephenson, in a speech which he made at a dinner given to him by the citizens of Montreal on the 19th of August, 1853, said on that occasion:—

"I cannot sit down without referring to the all important subject of a bridge over your magnificent river. Abundance of information was brought to me in England by my esteemed friend Ross, during the late visit he paid to that country, so that I was able to get a *good notion of what the bridge was to be* before I came out here. The first idea was certainly startling. I had been here twenty years before, and the St. Lawrence seemed to me like a sea, and I certainly never thought of bridging it."

And on the same occasion he said :—

"I assure you I appreciate your kindness deeply ; and one of the proudest days of my life will be that on which I was called upon to confer with the Engineers of the Grand Trunk Railway on bridging the St. Lawrence."

There is nothing in the above extracts that would lead one to suppose, for a moment, that any other party than Mr. Stephenson could lay claim to the design for the Bridge as it now stands. But, towards the completion of the work, and just previous to Mr. Stephenson's death, an unpleasant correspondence took place in some English and Canadian newspapers on this subject.

An article appeared in the London *Morning Post*, in which it was stated that "to Mr. A. Ross is due the entire credit of the plan by which it (the Bridge) has been accomplished, adding, that the position of Mr. Stephenson was a very secondary one, being employed merely "as a consulting Engineer." It also stated that "the whole design for the Bridge was completed, the estimates made, and the contract entered into before even Mr. Stephenson was spoken to on the subject, and that the form of the piers and icebreakers was due to Mr. Ross." The author, over the signature of "Veritas," claimed for Mr. Ross the whole credit for the entire plan of the Bridge, and designated that gentleman "as the man to whom Canada and the world are indebted for conceiving the design of the Victoria Bridge, providing for it, and successfully overcoming all difficulties, and carrying out the details of the plan."

To this bold assertion, put forth in a prominent English paper, Mr. George Robert Stephenson, (his cousin then lying dangerously ill,) found himself bound to reply, as silence, to such a broad assertion would not only have left a stain upon a hitherto stainless character, of having appropriated to himself the credit of another man's design, but would have been construed into a silent acquiescence in the statement put forth.

The reply to this charge went on to say that,

" Mr. Stephenson, although he no doubt relied frequently and largely upon Mr. Ross, is by no means indebted to that gentleman, as the letter (in the *Morning Post*) would imply, even for the data on which his calculations were made. These data were chiefly collected by Mr. T. C. Keefer before Mr. Ross visited Canada, and Mr. Keefer handed over his material to Mr. Ross on leaving the service of the Company.

" All the details, from first to last, have been under Mr. Stephenson's supervision, and many of them worked out in his office in London, under my sole superintendence. The whole of the iron work has been designed in this office. It has been constructed, and some of the tubes put together temporarily in England, and it has all been shipped to Canada with detailed drawings, and instructions approved by Mr. Stephenson himself, so as to leave the parties on the other side little more than the duty of putting the pieces together as desired.

" The construction of the bridge was, from first to last, placed in the hands of Mr. Stephenson by the Railway Directors, with full power to appoint whomsoever he thought proper to assist him. The Directors had placed their reliance on his reports, and have held him responsible for the works. Mr. Stephenson would not have shrunk from the responsibility had any unforeseen failure or accident occurred, nor has he shrunk from defending both the principles and the details of his plan from the various attacks to which they have been subject.

" Allow me to add, however, that it is with great reluctance, and only as an act of justice to other parties concerned, that Mr. Stephenson authorizes me, and that I feel compelled to make this statement. Mr. Stephenson has always been, and always will be, ready to do ample justice to Mr. Ross, who has never

himself put forth the extraordinary pretensions claimed for him."

The concluding paragraph of this letter would have been quite satisfactory for public opinion on the matter, had Mr. Ross kept silent; but, in reply to Mr. G. R Stephenson, he called upon the Hon. John Young for a statement of the facts known to him when the site of the proposed bridge was examined in July, 1852. Mr. Ross, therefore, fairly endorsed the article in the Morning Post over the signature of "Veritas;" he, moreover, designated the letter of Mr. G. Stephenson as malicious, and written without the authority of Mr. R. Stephenson. Mr Young replied to Mr. Ross, stating, as before mentioned in these pages, that Mr. Ross had accompanied him to examine the various sites proposed for the bridge, and "when near the present site, Mr. Ross first suggested the idea of a tube or beam bridge, and exactly conveyed to my mind a description of the present structure. This was in the spring of 1852, one month after the arrival of Mr. Ross, and before it was possible for him to communicate with Mr. Stephenson."

Now it is not our desire to take one iota from the credit fairly due to Mr. Ross; on the contrary, he is entitled to the highest praise for the manner in which he performed the duties of Chief Engineer on this side of the Atlantic; but no one who has read the beautiful Report of Mr. Stephenson (which we have printed in full in the Appendix) can for a moment suppose that any other man than he conceived, designed, and carried out the Victoria Bridge in its present form. He had too many laurels on his brow, to seek, for one single moment, to detract from the fair fame of any man; and his name stands too high for any one to suppose that, if Mr. Ross was entitled to the credit of the design, he would not gladly have testified thereto.

As we said before, it is probable that Mr. Ross did make a design for a tubular bridge before Mr. Stephenson was appointed Engineer, but, if so, it must have been a very crude one. Mr. Stephenson merely said that "abundance of information was brought to me in England by my esteemed friend Ross, so that I was able to *get a good notion of what the bridge was to be* before I came out here;" but, in suggesting the form of a tubular bridge to Mr. Young, Mr. Ross was merely adopting the invention of Mr. Stephenson, which had been patented, and so successfully carried over the Menai Straits, two years before. Mr. Morton and Mr. Keefer are just as much entitled to the claim of being the first designers of the Victoria Bridge, as it now stands, as is Mr. Ross, when we take from it the merit of the tube principle, to which the last gentleman could lay no claim. Their lines, as regards the site of the bridge, are nearly identical; on any of the sites proposed by them a bridge could have been in safety constructed, and we presume that there could have been little difference in the form of the piers and the distances between them, as the cut water, or ice breaker, which now forms a part of the stone piers, was not the method first contemplated, even by Mr. Stephenson himself, as will be seen by the following extract from Mr. Stephenson's Report to the Chairman and Directors of the Grand Trunk Railway Company :

"In the first design for the Victoria Bridge, ice breakers, very similar to the above described by Mr. Keefer, were introduced, but, subsequently, the arrangement was changed, partly with a view of gaining the assistance of the whole weight of the bridge to resist the pressure of the ice before it became fixed, and partly for the purpose of obviating a considerable annual outlay."

Mr. Stephenson made no mention whatever, at the public dinner given to him at Montreal, *at which Mr. Ross was present*, of any design having been submitted to him

by that Engineer. He gives Mr. Ross full credit for all data collected by that gentleman, but says not one word of any plan having been submitted to him; and the only inference we can draw from this silence, is, that to Mr. Stephenson, alone, is due the credit for the Victoria Bridge, as it now stands, in all its details and perfection.

Mr. Ross' name was associated with that of Mr. Stephenson, in the contract entered into by the Grand Trunk Railway Company, with Messrs. Peto. Brassey, and Betts, in the same way as was Mr. Fairbairn's in the construction of the Conway Bridge; but it was more particularly necessary in this case, as Mr. Ross was to be the Chief Engineer on this side the Atlantic, and his position required to be determined and mentioned in the body of the contract, as the contractors could only be paid upon his certifying to the work having been properly performed. The contract states:—

"The contractors will make, build, and construct the said tubular bridge over the said river St. Lawrence at or near Montreal, according to the plans, sections, and specifications prepared and drawn by Robert Stephenson, of London, aforesaid, Civil Engineer, M. P., and Alexander McKenzie Ross, of Montreal, C. E."

But immediately following, it says:

"The Bridge when completed to be in perfect repair, and of the best and most substantial character, and to be approved of by the said Robert Stephenson."

Mr. Ross' name is here left out, as he was merely the Assistant Engineer.

Further on it states:

"That in the case of the death, refusal, or inability to act of the said Alex. McKenzie Ross, another engineer shall from time to time be appointed by the said Robert Stephenson in place of the said Alex. McKenzie Ross, and who shall have all the powers of the said Alex. McKenzie Ross. And in the event of the

death or refusal or inability of the said Robert Stephenson, the[n] all things then remaining to be done by the said Robert Stephenson shall be done by an eminent Civil Engineer to be appointed by the President for the time being of the Institution o[f] Civil Engineers in England, upon the requisiton of the partie[s] hereto, or either of them."

Here we see again the secondary position of Mr. Ross if Mr. Ross should die or refuse to act, Mr. Stephenson ha[s] full power to appoint another Engineer in his place; bu[t] if Mr. Stephenson should die, Mr. Ross is not to replace him but his position to be filled up by an eminent Engineer, appointed by the President of the Institution of Civil Engineers.

In the next paragraph of the contract it states:

"That if any question or difference of opinion shall aris[e] between the parties hereto, as to this agreement—or any matte[r] connected therewith or arising thereout in any way, &c., it shal[l] be referred to the absolute decision of the said Robert Stephenson, as sole arbitrator; and the decision of the said Rober[t] Stephenson shall be binding and conclusive upon both partie[s] as to the question or difference of opinion so referred to him."

It is the duty of every Assistant Engineer, and more particularly in the case of Mr. Ross, who was so far separate[d] from the principal, to collect all data, and to afford such suggestions from time to time, as he may, in his professiona[l] opinion, consider advantageous to submit to the Chief Engineer, with regard to any alterations deemed necessar[y] to the works constructing under his superintendence, an[d] which, from his more perfect knowledge of the locality &c., he is expected to be better informed upon than th[e] head of the department. And no doubt Mr. Stephenso[n] received many valuable suggestions from Mr. Ross durin[g] the progress of the work, particularly with regard to the icebreakers, piers, &c., as we find mentioned in a lette[r] from Mr. Ross to Mr. Stephenson, dated 30th Nov., 1855

Mr. George R. Stephenson distinctly states, in his letter dated 22d Sept., 1859:

"Mr. Ross, from his first connection with the Victoria Bridge, has been, together with the rest of the Engineering staff, under the pay of Mr. Stephenson, the Chief Engineer. Mr. Ross has not ventured at any time on any important work connected with the bridge, except upon instructions or after consultation with Mr. Stephenson, nor has Mr. Ross had to bring any originality of *conception* or *ingenuity* of adaptation to bear upon either the designs or the details since the work commenced."

As this assertion was never, to our knowledge, directly denied, we may fairly place on record in these pages the names of the following gentlemen and the merits to which they are justly entitled.

To the Hon. John Young, then, is Canada indebted for the conception of a feasible plan of a bridge across the St. Lawrence on its present site, and which would not have been constructed at the present day, had it not been for the great personal exertions, and the pecuniary assistance rendered by him to obtain the surveys. He it was who gave its first motive action.*

Mr. Morton's name must be associated with its history, as the engineer who first reported on the practicability of constructing a bridge across the St. Lawrence, somewhere near its present site.

To Mr. Keefer was Mr. Stephenson indebted for all the valuable data collected and mentioned in Mr. Keefer's report, and this engineer is justly entitled to the full credit of having designed the first plan of a bridge over the St.

* Nor is this the only public work of importance and utility to the great commercial interests of the Province for which the people of Canada are indebted to the Hon. John Young, as is well known to his fellow citizens, though not generally so to strangers. It would be out of place, however, to allude to them in these pages.

Lawrence which could have been successfully carried int effect, as has been subsequently proved by the constructio of the Victoria Bridge upon nearly the same site.

To Sir William E. Logan was Mr. Stephenson indebte for his first ideas of the probable effect of the pressure o the ice against piers.*

Mr. Ross, as Chief Engineer on this side of the Atlantic is entitled to very great credit for his careful supervisio of the work, which was accepted from the hands of the con tractors on the 17th December, 1859, by the two Englis engineers sent out for that purpose, according to the ex pressed wish of Mr. Stephenson before his death, as a per fect structure, "completed satisfactorily according to th true spirit and meaning of the specification."

Mr. Hodges, as the Agent and Chief Engineer for th contractors, is entitled to unbounded praise for his untirin energy, and the skill and management with which he s successfully conducted this great and responsible under taking, in which he was most ably assisted by the assistan engineers, C. Legge and G. Duncan.

The position of Mr. Hodges was indeed a trying one Entrusted with the carrying out of the most important en gineering work at that period constructing in the world with a deep responsibility of failure resting upon his shoul ders, with the daily superintendence of the work of up

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"*I have read and studied with pleasure the whole of the varied conditions of the river, from the commencement of the formation of the ice to its breaking up and clearing away in the Spring. To this memoir I am much indebted for a clear comprehension of the formidable tumult that takes place at different times amongst the huge masses of ice on the surface of the river, and which must strike the eye as if irresistible forces were in operation, or such as, at all events, would put all calculations at defiance.—*Stephenson's Letter to the Shareholders of the G. T. R. Co. 2d May*, 1854.

vards of 2000 men variously employed, whom he had to rganize and discipline, to ensure a proper performance of heir respective duties, and with a host of difficulties to enounter, monetary, engineering, and incidental, all of more r less magnitude, he required a master mind of no ordinary apacity to grapple with them, and an energy and perseverance of no ordinary character. The best tribute we can pay his gentleman is by quoting the words of the Lord Bishop f Montreal, spoken at the dinner given by Mr. Hodges on he part of the contractors, to celebrate the completion of he great work which he constructed :

" For the rest, I have only to say, that I am here to-day, not ıerely because I have taken a great interest in watching this igantic work of which you have heard—in watching each ier in its erection, or in watching its multitudinous rivets hich have connected the vast tubes together; not merely ecause I wished to join you in celebrating its opening, but beuse I wished to pay personal respect to Mr. Hodges, who, in ter years, will be remembered with pride—remembered for his tegrity, honesty, and ability, and the Christian principle with hich he has endeavoured to provide for the education of the oung and the spiritual supervision of all people connected with e works on which he was engaged."

But to Mr. Stephenson, alone, is due the design of the ictoria Bridge, as we now see it, in all its details, symmetry, d strength: the last monument of his fame and genius; hich is likely to mock for ages the hydraulic force, and d defiance to the glacial ramparts, of the great river over hich it strides, until its materials mould away in the ean of time, and its history is forgotten by future genetions.

Having, thus, fully gone into the merits and claims of ose parties whose names were connected intimately with e scientific part of the work, we must not pass over the mes of two gentlemen, the Hon. John Ross and the Hon.

F. Hincks, whose exertions and political influence had mu to do in carrying out our great line of national railw and obtaining that confidence of the English people in t good faith of Canada, which has caused them to invest much of their surplus capital in our public undertakin and which has been attended with such beneficial resu in the development of the resources of this province.

The grand scheme of a national railway, for a distar of 1200 miles, and passing through the richest parts Canada, would still have been an imperfect undertakir without some means of communication, at all seasons of t year, between the north and south shores of the St. La rence; and the whole line of the Grand Trunk Railw would have been more of a provincial undertaking, witho the bridge, which was the key required to open the int course of the whole province to the Atlantic seaboard.

These important considerations bore with their full for upon the Directors of the Grand Trunk Railway Compan and the people of Canada felt the necessity of the unde taking.

They had now faith in the surveys and reports made to the practicability of its construction. But the Directo of the Company, in order to gain the confidence of tl English capitalists, and ascertain, beyond doubt, that bridge could in safety be constructed, deemed it pruden before commencing a work involving such an immense ou lay, to have the advice of the most eminent engineer the could counsel, and, accordingly, decided in 1852, to obtai the services of Mr. Stephenson.

But before commencing a description of the bridge, an the difficulties to be overcome in its construction, we car not refrain here from giving a long extract from a pape read by Sir W. E. Logan, Provincial Geologist, before th Royal Geological Society, London, the perusal of which wi

ell repay the reader, as it so graphically illustrates the ocal phenomena which take place in winter opposite to this ity, by which the vast mass of ice is set in motion by the hole hydraulic force of the river and thrown up into huge iles one above the other, fifty feet in height, presenting to ie eye of the beholder, a power sufficient, apparently, to rush beneath its pressure any obstacle, and tear from its ase masonry of the hugest proportions:

"There is no place on the St. Lawrence where all the phe- omena of the taking, packing, and shoving of the ice are so randly displayed as in the neighbourhood of Montreal. The iolence of the current is here so great, and the river in some laces expands to such a width, that, whether we consider the rodigious extent of the masses moved or the force with which iey are propelled, nothing can afford a more majestic spec- cle or impress the mind more thoroughly with a sense of ir- sistible power. Standing for hours, together, upon the bank verlooking St. Mary's current, I have seen league after league ice crushed and broken against the barrier lower down and iere submerged and crammed beneath. And when we reflect iat an operation similar to this occurs in several parts from ake St. Peter upwards, it will not surprise us that the river iould gradually swell.

"By the time the ice has become stationary at the foot of St. ary's current, the waters of the St. Lawrence have usually sen several feet in the harbour of Montreal, and, as the space rough which this current flows affords a deep and narrow issage for nearly the whole body of the river, it may well be iagined that when the packing here begins the inundation pidly increases. The confined nature of this part of the iannel affords a more ready resistance to the progress of the e, while the violence of the current brings such an abundant pply and packs it with so much force, that the river, dammed by the barrier which in many places reaches to the bottom, tains in the harbour a height usually twenty, and sometimes enty-five feet, above its summer level; and it is not uncom- on, between this point and the foot of the current, within the stance of a mile, to see a difference in elevation of several

feet, which undergoes many rapid changes, the waters ebbing (flowing according to the amount of impediment they meet wit in their progress from submerged ice.

"It is at this period that the grandest movements of the ic occur. From the effect of packing and piling, and the accun ulation of the snows of the season, the saturation of these wit water, and the freezing of the whole into a solid body, it a tains the thickness of ten to twenty feet and even more : an after it has become fixed as far as the eye can reach, a sudde rise in the water (occasioned, no doubt, in the manner mentior ed) lifting up a wide expanse of the whole covering of the rive so high as to free and start it from the many points of rest an resistance offered by the bottom, where it had been packe deep enough to touch it, the vast mass is set in motion by th whole hydraulic power of this gigantic stream. Proceedin onward with a truly terrific majesty, it piles up over every ot stacle it encounters ; and when forced into a narrow part (the channel, the lateral pressure it there exerts drives the bo dage up the banks, where it sometimes accumulates to th height of forty or fifty feet. In front of the town of Montreal there has lately been built a magnificent revetment wall c cut limestone, to the height of twenty-three feet above the sum mer level of the river. *This wall is now a great protectio against the effects of the ice.* Broken by it, the ice piles on th street or terrace surmounting it and there stops ; but before th wall was built, the sloping bank guided the moving mass up t the walls of gardens and houses in a very dangerous manner, an many accidents used to occur. It has been known to pile u against the side of a house, distant more than 200 feet from th margin of the river, and there break in at the windows of th second floor. I have seen it mount a terrace garden twent feet above the bank, and crossing the garden enter one of th principal streets of the town. A few years before the erectio of the revetment wall, a friend of mine, tempted by the com mercial advantages of the position, ventured to build a larg cut stone warehouse. The ground floor was not more tha eight feet above the summer level of the river. At the takin of the ice, the usual rise of the water of course inundated th lower story, and the whole building becoming surrounded by a frozen sheet, a general expectation was entertained that it woul

prostrated by the first movement. But the proprietor had ken a very simple and effectual precaution to prevent this. ıst before the rise of the waters, he securely laid against the les of the building, at an angle of less than 45°, a numr of stout oak logs a few feet asunder. When the movement me, the sheet of ice was broken, and pushed up the wooden clined plane thus formed; at the top of which, meeting the ıll of the building, it was reflected into a vertical position, d, falling back in this manner, such *an enormous rampart of was in a few minutes placed in front of the warehouse as comtely shielded it from all possible danger.* In some years, the has piled up nearly as high as the roof of this building. ıother gentleman, encouraged by the security which this ırehouse apparently enjoyed, erected one of great strength d equal magnitude on the next water-lot, but he omitted to otect it in the same way. The result might have been anticited. A movement of the ice occurring, the great sheet uck the walls at right angles and pushed over the building if it had been a house of cards. *Both positions are now seed by the revetment wall.*"

Mr. Stephenson, upon being appointed the Company's ıgineer, considered the subject of such importance, that went to Canada, for the purpose of dealing with it, in 53, and, after examining the facts, made a public declaion of his opinion that a bridge was practicable. On 2nd May, 1854, Mr. Stephenson wrote to the Grand unk Railway Directors, in which he considered the ole question in three branches—

1st. As to the description of bridge best adapted for the situation.

2d. The selection of a proper site.

3d. The necessity for such a structure.

Upon the first point he did not hesitate to adopt ubular bridge, as the best description fitted for a permat, safe, and substantial structure in such a situation.

On the 2nd point he was not a little influenced by conrations affecting the flow of the river, and those almost

"irresistible forces" consequent upon the breaking up o the ice. Writing on this subject, he says:—

"The origin of these powers is simply the gravity of th mass occupying the surface of the water with a given declivit up to a point where the river is again clear of ice, which, i this case, is at the Lachine Falls. This is unquestionably th maximum amount of force that can come into play; but it effect is evidently greatly reduced—partly by the ice attachin itself to the shores, and, partly by its grounding upon the bed o the river. Such modifications of the forces are clearly beyon the reach of calculation, as no correct data can be obtained fo their estimation; but if we proceed by omitting all consideratio of those circumstances which tend to reduce the greatest forc that can be exerted, a sufficiently safe result is arrived at.

"In thus treating the subject of the forces that may be occa sionally applied to the piers of the proposed bridge, I am full alive to the many other circumstances which may occasionall combine in such a manner, as, apparently, to produce severe an extraordinary pressure at points on the mass of ice or upon th shore, and, consequently, upon the individual piers of a bridge Many inquiries were made respecting this particular view, bu no facts were elicited indicative of forces existing at all ap proaching to that which I have regarded as the source and th maximum of the pressure that can at any time come into operatio affecting the bridge.

"I do not think it necessary to go into detail respecting the pre cise form and construction of the piers, and shall merely state that, in forming the design, care has been taken to bear in min the expedients which have hitherto been used and found success ful in protecting bridges exposed to the severe tests of a Canadian winter, and the breaking up of the ice of froze rivers.

On the 3rd point, Mr. Stephenson proceeds to say:—

"I now come to the last point, viz., the necessity of this larg and costly bridge.

"Before entering on the expenditure of £1,400,000 upon on work in any system of Railways, it is of course necessary to con sider the bearing which it has upon the entire undertaking i

rried out, and also the effect which its postponement is likely produce.

" These questions appear to me to be very simple and free from y difficulty.

" An extensive series of railways in Canada, on the north side the St. Lawrence, is developing itself rapidly; part of it is eady in operation, a large portion fast progressing, and other es in contemplation, the commencement of which must speed- take place.

' The commerce of this extensive and productive country has rcely any outlet at present, but through the St. Lawrence, ich is sealed up during six months of the year, and therefore y imperfectly answers the purposes of a great commercial tho- ghfare.

Experience, both in this and other countries where railways e come into rivalry with the best navigable rivers, has ionstrated, beyond the possibility of question, that this new cription of locomotion is capable of superseding water car- ;e, wherever economy and despatch are required; and even ;re the latter is of little importance, the capabilities of a rail- ', properly managed, may still be made available, simply for nomy.

The great object, however, of the Canadian system of rail- s is not to compete with the river St. Lawrence, which will inue to accommodate a certain portion of the traffic of the ıtry, but to bring those rich provinces into direct and easy nexion with all the ports on the East coast of the Atlantic, ı Halifax to Boston, and even New York, and consequently, ugh these ports, nearer to Europe.

If the line of Railway communication be permitted to remain red by the St. Lawrence, it is obvious that the benefits which system is calculated to confer upon Canada must remain in a t extent nugatory, and of a local character.

The province will be comparatively insulated, and cut off that coast to which her commerce naturally tends; the c from the West must either continue to adopt the water nunication, or, what is more probable,—nay, I should say, *in*,—it would cross into the United States by those lines ly completed to Buffalo, crossing the river near Niagara.

No one who has visited the country, and made himself ac-

quainted, only partially, with the tendencies of the trade whic is growing up on all sides in Upper Canada, can fail to pe ceive, that, if vigorous steps be not taken to render the Rai way communication with the Eastern coast through Low Canada uninterrupted, the whole of the produce of Upp Canada will find its way to the coast through other channel and the system of lines now comprised in your undertaking wi be deprived of that traffic upon which you have very reasonabl calculated.

"In short, I cannot conceive anything so fatal to the sati tisfactory development of your Railway as the postponeme of the bridge across the river at Montreal. The line canno in my opinion, fulfil its object of being the high road for Ca adian produce, until this work is completed; and looking at t enormous extent of rich and prosperous country which yo system intersects, and at the amount of capital which has bee already, or is in the progress or prospect of being expende there is in my mind no room for question as to the expedienc indeed, the absolute necessity of the completion of this bridg upon which, I am persuaded, the successful issue of your gre undertaking mainly depends."

Mr. Stephenson's design for the Victoria Bridge w severely criticized at the time by some very eminent Englis Engineers, particularly as being more expensive than th "Trellis Girder," or than the "Single Triangular Girder, recently called "Warren" from a patent obtained for it by gentleman of that name; but Mr. Stephenson so clearl demonstrated his own views to the G. T. R. Directors, an so logically and forcibly discussed the whole question in Report,--which is a perfect model of scientific reasoning fro the pureness, simplicity, and clearness with which he plac his arguments and opinions side by side with those of h critics,—that the Directors, unhesitatingly, decided upo adopting the bridge according to the design and estima submitted to them.

In 1854 the work was commenced by the contractor Messrs. Peto, Brassey, and Betts, under the sole superi

ndence of Mr. James Hodges, the Engineer who acted
ı the part of the contractors; and, although the contract-
s were impeded in their progress, in consequence of the
onetary crisis, which affected their own and the affairs of
e country generally, the bridge was completed, and ac-
pted from off the contractors' hands, on the 17th De-
mber 1859, being within one year of the time specified.

Before proceeding to give the reader a description of the
ictoria Bridge, it may not be uninteresting to furnish a
ort account of its great rival the Britannia Bridge (so
lled from the rock on which its centre pier is raised), and
ich, although not near so long as the Victoria, still is pre-
inent among bridges for the lofty height of its towers,
d for the length and dimensions of its tubes, which are the
gest of any yet constructed upon the tubular principle.

The Conway Bridge, constructed over the Conway river
Wales, was the first tubular bridge ever constructed.
has only one span, 400 feet in length, and was the joint
oduction of Robert Stephenson and William Fairbairn.
is bridge was in itself an instance of "triumphant suc-
ss in design and execution." It was followed, imme-
tely after, by the Britannia Bridge over the Menai
raits, in the middle of which a rock rises from the bed of
e sea, upon which a tower of masonry is erected 200 feet
height. At the clear distance of 460 feet, another tower
built on either side of it; and, at the distance of 230 feet
m each of these towers, a continuous abutment of masonry,
6 feet in length, is erected, which constitute the two
ds of the bridge. The Britannia tower, in the centre of
e Straits, is 62×52.5 ft. at the base, and reduced, by
tter, to 52×45.5 ft. at the height of 102 feet above
e high-water line, at which level the tubes pass
rough it; and the elevation of the whole tower above high-
ter level is the lofty height of 200 feet, or nearly

230 feet from the bottom of the foundation on the rocl The stones used, as in the Victoria Bridge, are of gre size: some of them weigh from 10 to 14 tons. The cı bical contents of this single tower, if solid, would excee 575,000 cubic feet, but, as it is constructed with hollo spaces or chambers within it, the quantity of stone actuall used in its construction is 293,150 cubic feet. The tot weight of the masonry is 200,000 tons, and about 387 to of cast-iron in beams and girders are built in it.

The abutments of this bridge terminate with projectin pedestals, on which four couchant lions, in the Egyptia style and of colossal dimensions, face the approaching vis tors, and seem to guard the entrance to the iron wonder b hind. Each of these lions measures 25 feet in length an 12 feet in height, weighing about 30 tons,—noble specimer of sculpture.

There were four spaces in the Britannia Bridge to b covered by the iron tubes, two of 460 feet and two of 230 and, as each tube serves for only one line of rails, 8 tubes wer required. The four largest being over the deep water, the were constructed on the shore on timber platforms, an conveyed in flat-bottomed vessels, or pontoons, to th towers, and were raised to their required elevation, of 10 feet above the high-water level, by hydraulic presses; an by this arrangement, all scaffolding across the Straits wa avoided, and only one half of the channel interrupted at time.

When the work was completed, the four separate tube were united together, so that each tube is of the length c 1513 feet, or about $\frac{2}{7}$th of a mile; and to form this conne tion, short tubes were constructed within the towers t effect their ultimate union.

But the part in the design of this stupendous bridg which evinced the boldness and confidence of its Enginee

ı his own powers, was the raising of a weight of 1800 tons ırough an elevation of 102 feet, over a rapid tide rushing ırough the Straits, and utterly without scaffolding of any ind over the opening, between the towers, 460 feet in idth.

The power applied for this Herculean purpose was those ıachines known as "Hydraulic" or "Hydrostatic Presses," description of which it is unnecessary to give in these ages.

As the tube steadily and slowly ascended under the owerful pressure applied, the space underneath was carelly built up with brick work and cement. Mr. Stephenson ıd followed up the tube, inch by inch, as it ascended, with ıckings of wood 1 inch thick, until there was sufficient om to replace the packings with bricks; and if this wise ecaution had not been adopted, an accident of a very serious ıture would have occurred, owing to the bursting out of the ttom of the cylinder of the hydraulic press, weighing out 4½ tons, which, being entirely separated from the rest the casting, fell, with terrific force, on the top of the tube low, a depth of from 70 to 80 feet. The tube would ve fallen, in consequence, through a space of 3 feet 6 inches the brickwork below, but was arrested by the packings wood so wisely adopted. As it was, the total falling was ly about *one inch*, and, although it only fell through that ort space, it broke down iron beams sufficient to bear 0 tons weight.

Let us now draw a comparison between the dimensions these rival bridges; by which it will be seen, that, hower gigantic are the towers that uphold the ponderous bes of the Britannia Bridge, as a work of magnitude and it is far surpassed by the Victoria in the difficulties be encountered in its erection, and in its general prortions.

	Brit. Bridge. Ft. in.	Vict. Bridge. Ft.
Length between the abutments	1,513	6,600
Total length including approaches	1,841.6	9,084
Number of piers	2	24
Greatest distance between piers	460	330
Height of Centre Tower (or pier) over high water	102	60
Total height of tower	200	60
Cubical contents of masonry in whole structure	1,300,000	3,000,000
	Tons.	Tons.
Total weight of iron in single line of tubes	4,825½	8,000
Number of rivets in do do	1,000,000	2,000,000
Cost of Work		$6,300,000
Time occupied in completion		5½ years

We will now proceed with a general description of the Victoria Bridge.

The Victoria Bridge is that known as the tubular or beam bridge, and consists of a series of iron tubes resting on 24 stone piers, with a distance between each pier of 242 feet, except the centre opening, which is 330 feet in length. Its total length between the abutments is 6,600 feet, or a mile and a quarter. The bridge is approached by two massive embankments, the one on the Montreal side being 1,200 feet, and that on the south shore 800 feet in length; which together, including the abutments, make the total length of the bridge 9,084 feet, or a mile and three quarters nearly.

Laying off the Work.

The first step taken, after the surveys were fully completed, and the line over which the bridge was to pass decided upon, was to lay off the line of the abutments and piers.

This work the Engineers were able to do, whilst the ice was on the river, with the most minute correctness. Then

he centre of the foundation of each pier was marked, which vas thus performed. "Guides" were framed, so that long ron rods could be lifted and let fall on one spot, technicaly called by masons "jumped," until a hole was drilled nto the rock, in the bed of the river, into which a bolt vas driven and a float attached. By these means the precise entre of each pier was established to within a few inches.

Dams.

The first step to be taken before the foundation of the iers, or abutments, could be laid, was the formation of offer-dams, which, for such a structure and in such a river s the St. Lawrence, required to be of no ordinary magniude and cost.

Two kinds of dams are said to have been used, each posessing over the other certain advantages. Those called oating-dams were framed, and consisted of two parts. One art had three sides of a rectangular form, the sides being onger than the ends, but the upper end was formed of two ieces meeting in an angle up stream, in order to turn off he current. They were carefully and strongly built, and aulked; and were then towed into position by a powerful teamboat, and their precise places determined by a transit rom the shore. On a given signal the sluice-gate was pened, and the dam sunk into its required place. The rea within the dam was of course still water, and within s sides was constructed another dam; on the completion of which, the water was pumped out.

The other form of dam was of the ordinary cribbing of he country, and, owing to the rapidity of the stream, unsual care had to be observed in its construction.

A dam of this form, consisted of a double row of cribing, each 14 feet wide, and with seven to eight feet of uddle; and between them, and the part turned up stream,

was a regularly built ice-breaker to withstand the ice of the winters if necessary. The comparison between the respective merits of these two classes of dams may thus be made. The floating dam could be used several times, and was found to answer best in deep water; but its great disadvantage was, that the masonry of the pier had to be completed within the working season, as it could not be made sufficiently strong to resist the pressure of the ice in winter, hence, it had to be removed; also, when the period arrived to construct the tube, the side of the pier was naked, and there was no point whence to start the scaffolding to support the tube-truss.

With the coffer-dam this foundation for the scaffolding existed, and, hence, it was only necessary to frame one centre scaffold; whereas, with the floating-dams, three such constructions were necessary, viz., the centre, the frame, and the scaffold foundation at the side of each pier. Nor was this consideration an unimportant one, for such foundation had to be obtained by sinking scows and driving piles around them to keep them in position.

From either dam the framing was carried up above the height of the pier, and on the capping piece, or sill, was run a railway to admit of the passage of a travelling machine, which, mounted with a crab, admitted a contrary passage on itself. Hence stones of 17 tons were moved into position with the greatest facility. On the platform of the dam were erected sheds to cover the steam-engine, the blacksmiths' and carpenters' shops and storeroom.

The foundation of the piers seldom exceeded 22×90 ft., whereas the area required for the dams was 120×210 ft. to allow a large margin in case of its not sinking in the exact spot.

Nothing could be better than the pumps used by Mr. Chaffey, the contractor for masonry on the south side of the

iver. They were worked centrifugally, and threw 800 gallons a minute. It was calculated that his pumps low-red the area of water in the dam at the rate of two feet er hour, and emptied a dam in eight or ten hours.

When the dams were perfected and emptied of water, he staging constructed, the travelling machine in opera-ion, stone delivered and cut ready to be laid on its bed, he next process was that of cleaning out the bed of the iver for the foundation.

Bed of the River.

It was the general impression that the bed of the river as rock, of that kind termed "trap," but in the rogress of the work it was found that it was formed f large boulders heaped together in masses, the terstices being filled up with gravel, sand, and mud, in any instances forming a hard concrete mass, and in others e reverse, beds of quicksand and mud being as frequent as y other. Three thousand tons of such material had to cleared out of the foundation of No. 5 pier. One of e boulders taken out weighed 30 tons, and masses of ree and four tons were strewed thickly over the surface.

The depth, therefore, to be excavated, before reaching ck, greatly increased the cost to the contractors of the asonry in the piers.

We should observe, that in the southern half of the idge (for it was commenced at both ends at once) the affolding was not used, but a compound derrick, the in-ntion of Mr. Chaffey, worked by a high-pressure engine, pplied its place. Much ingenuity was shown in obtain-g this motion, as the stone could be placed by it in any sition, for the derrick had a motion which admitted of ecisely placing the stone in position. It was capable handling stones eleven tons in weight.

The Approaches and Abutments.

The bridge is approached from the north shore by an embankment 1,200 feet, and another from the south shore 800 feet in length, and the waters, thus embayed, now find their way through the piers of the bridge, by which the velocity of the current has been much increased.

The abutments are each, at the base, 278 feet long, and are built hollow, having eight openings or cells 48 feet in length and 24 feet in width, separated by cross-walls 5 feet in thickness. The flank-wall on the down-stream side rises nearly perpendicular, and is seven feet in thickness; that on the up-stream has a slope from its foundation upwards, the thickness of the walls is 12 feet, and they present a smooth surface to facilitate the operation of the ice, on which account its form had been thus determined. To ensure greater resistance to the pressure of the ice, the cells are filled up with earth, stone and gravel, so that one solid mass was thus obtained.

The embankments are solid, composed of stone 36 feet above the summer water level, and of the width of 30 feet on the upper surface, formed with a slope of one to one on the down side of the stream, and a hollow shelving slope of about 2½ to one on the upper side. The slopes are faced with stones set on edge at an average angle of 45°.

Piers.

The piers are solid, and constructed, as well as the abutments, of the finest description of ashlar masonry, laid in horizontal courses measuring from 7 to 12 feet on the bed and from 3 ft. 10 in. to 2 ft. 6 in. thick, above the water level, and thence varying into a course of 18 in. under the plates. The stones were cut with the greatest exactness, seldom requiring to be re-dressed after being laid

They weigh from 7 to 17 tons; the average weight of each stone is $10\frac{1}{2}$ tons. All the beds and vertical joints are square, dressed in the most efficient and workmanlike manner; the external face rough, and without any pick or tool marks, but with the natural quarry face preserved.

The string-courses and copings are fair-picked, dressed throughout, and neatly pointed and weathered, and a tool-draft, eight inches wide, on each quoin. Each course of the ice-breaker is secured with fox-wedged bolts of $1\frac{1}{2}$ inch iron, which pass through into the 2nd and 3rd courses under it; and the horizontal joints are cramped together with iron cramps 12×5 inches, through which the bolts pass.

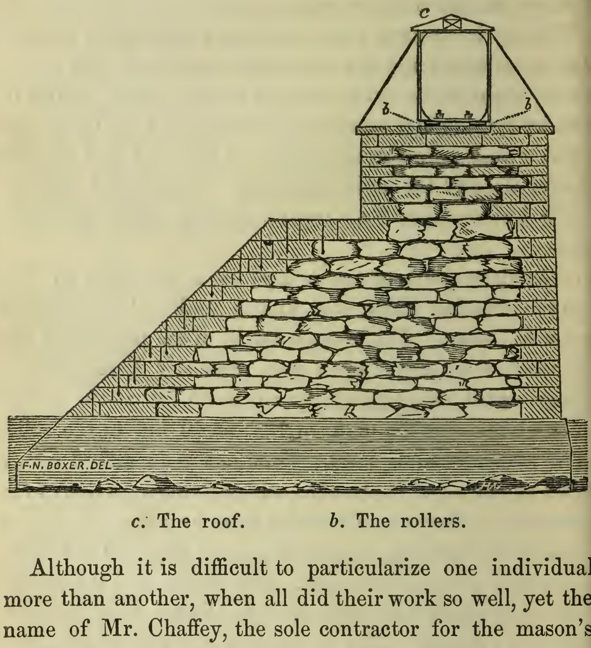
The description of stone used is a limestone of the Lower Silurian order, and known under the Geological term of Chazy. The average height of the piers above the summer water level is 48 feet, gradually rising from a height of 36 feet at the abutments to 60 feet at the centre pier, giving a grade of 1 in 132, or 40 feet to the mile. The centre span is level. Each pier is furnished with a solid cut-water, or ice-breaker, which forms a portion of the pier itself. They are of a wedge form, and slope from their foundations upwards, terminating in an angle 30 feet above the summer level of the river. Their use, and the protection they afford, have already been alluded to in Mr. Stephenson's Report. The dimensions of a pier at the junction, with the cut-water, are 16×48 ft., but the whole transverse side of a pier at the foundation, including the cut-water, which extends up the stream, is 16×90 feet.

The foundations, of course, vary; some are as low down as 20 feet below the water.

The whole of the ashlar is laid in hydraulic cement, in the proportion of 1 part sand to 1 part cement. The

backing, from the level of the surface water upwards, is in common mortar.

The following is a section of a pier and tube:—



c. The roof. *b.* The rollers.

Although it is difficult to particularize one individual more than another, when all did their work so well, yet the name of Mr. Chaffey, the sole contractor for the mason's work for the southern half of the bridge, deserves especial mention. Few people can realize how much of labour and mental anxiety is saved to an engineer who has to deal with an honourable, energetic, and talented contractor, and all this was combined in Mr. Chaffey.

Our space will not allow us to enter into an account of the ingenious expedients he adopted for the saving of labour; and we regret, for the same reason, that we cannot enter into a description of his Derrick and Steam Traveller, a

model of which we hope some day to see in the Exhibition Building, in this city, of the L. C. Board of Arts and Manufactures. For beautiful mechanical contrivance, simplicity, and capability of power, his compound Derrick is foremost among lifting-machines.

The best tribute, as a man, we can pay to Mr. Chaffey, is to say, that of him all men speak well.

Tubes.

The plates of the tubes are of various dimensions and thicknesses. Those forming the sides are reduced in thickness from the ends towards the middle, varying from $\frac{4}{16}$ to $\frac{12}{16}$ of an inch. The joints are strengthened with Tee irons. The kelsons are placed transversely across the bottom of the inside of the tubes, and are 10 inches in depth. They are spaced 7 feet apart and are secured to the Tee bars by gussets, and support the pine longitudinals, or stringers, which carry the rails. The longitudinals are about 12×12 inches in section, and are kept in place by wrought iron flanges which are bolted to the kelsons. This arrangement allows the tubes to contract and expand without disturbing the pine longitudinals and the rails which rest upon them. They move freely between the flanges which form their lateral support.

The plates are all butt-jointed, having a covering plate over the joints on the outside, which is firmly rivetted through to the Tee iron on the inside of the tube; and covering plates, both inside and out, are placed over all the horizontal joints.

The centre tube, being so much longer than the others, has an additional thickness in the plates, and longitudinal kelsons are rivetted to the top in place of the Tee bars used in the small tubes. The Tee bars and gussets are are also considerably larger.

This tube is connected, at one end, to one of the large

piers; the other end is left free, resting upon the iron rollers.

The iron brackets protecting the exposed surface of the top of the two large piers are partly glazed, and at the sides of the brackets are iron blinds, through which a splendid view of the massive masonry of the piers and ice-breakers can be obtained; but on account of the great risk that strangers, particularly women, would be exposed to in the narrow tube during the passing of a train, the authorities very properly refuse admission to the public.

Between the bottom of the tube and the stone work of the pier, is introduced creosoted tamarac covered with asphaltic felt. The object of this is to give elasticity between the iron work and the stone.

On one side of the interior of the bridge is a planked footpath 3 feet in width, resting on the kelsons. It is only intended for the use of the *employés* in charge of the bridge. There is no footway for passengers on the outside of the bridge.

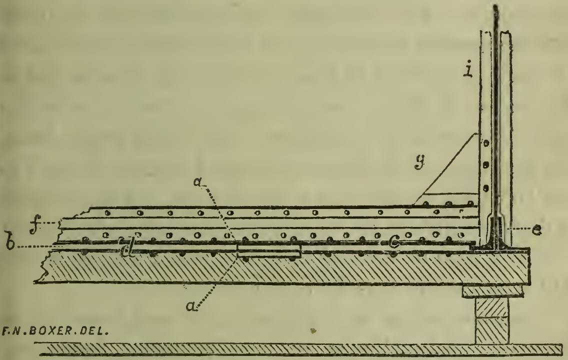
The greatest difference caused by expansion in the length of a tube of 260 feet, registered between the greatest extremes of temperature, is under three inches. At one end of the bridge is placed an indicator for registering the daily contraction and expansion of a tube. The telegraphwires pass underneath the tubes.

The deflection of a single tube, under the severest test that could be brought to bear upon it, was $\frac{7}{8}$ of an inch; that of the largest tube was $1\frac{7}{8}$ inches. Upon the load being removed, the tubes returned immediately to their original level.

The following was the method adopted for putting the tubes together:

After the staging or scaffolding was completed, upon

which a tube was to be built, blockings, supporting cross ties, were placed at intervals of about four feet for the whole length of a tube, and were raised sufficiently above the floor of the scaffolding to admit of the rivetters working between this floor and the bottom of the tube; at the same time, the requisite camber of the tube was carefully preserved, to allow of its settling down to a level when the scaffolding was removed. The centre line of the tube was then carefully struck on the cross ties which were placed to support the bottom plates. The plating was then commenced, either at the "bearing" or "roller" end, as the case might be. As the plates were all ready marked, punched, and numbered, each plate having its own particular place assigned for it in the tube, it was but a simple process to place them in position, which was thus performed :—



1st. The "bottom strips," *a* on plan, which join the plates making up the width of the tube, were laid down; then the "bottom plates," *d*; next the "cover plates," *c*; the packings, *b*; the angle irons, *e*; the cross kelsons, *f*; and the tee irons, *i*. As the plating proceeded, the rivetters followed up their work here and there with rivets, to keep the pieces toge-

ther; and when the bottom was completed, the side plates which were riveted into large sheets on shore, were commenced at the *centre* of the tube and proceeded with towards the ends. As fast as these large sheets, *h*, were placed together, the bottom "gussetts," *g*, which join the sides with the kelsons, were bolted in, and the top kelsons raised to position.

The laying of the top plates of the tube was but a repetition of the mode adopted for the bottom ones. Particular care, however, had to be taken in watching the camber of the tube as its weight increased, and wedges were provided under the blocking to raise it up, if required.

We mentioned that the tubes of the Britannia Bridge, after being placed in position, were connected with short tubes built in the towers so as to form one continuous length from shore to shore. In the Victoria Bridge a different arrangement was necessary on account of its grade, and the greater expansion and contraction of iron during the sudden extremes of temperature in this variable climate. The tubes of the Victoria Bridge are only connected in pairs. They cover two openings of 516 feet in length, including bearings, and contract and expand on iron rollers. They are 16×19 ft. at the ends of the Bridge, but they increase in depth towards its centre, at which point they are 16×22ft.

The weight of two united tubes, with rails, &c., is about 514 tons, or 257 tons for each opening.

The construction of this character of work is now so well known that much allusion to it is not necessary. Moreover, it is simple in the extreme, being formed of boiler plate rivetted together with angle irons and lateral and transverse braces, as shewn in foregoing illustration. The skill lies in reducing this boiler iron to such dimensions that there is no unnecessary material to add to the weight and to the expense, and yet obtaining a sufficiency of strength.

Accordingly, where the sides of the tube require strength, as at the abutment. Thus it will be seen that for the top and bottom of the tube the greater strength is at the centre, whereas the sides have most material where the span starts.

Thus, taking our data in all cases from the centre, the following shows the component parts of the tube :—

TOP PLATES.

From Centre.	L'ngth of Division.	Sectional Area.		Total Area.	Thickness of Plate.
		Plates.	Strips, Tee and Angle Irons.		
	′ ″				
1	11.00	125	$92\frac{1}{16}$	$217\frac{1}{16}$	$\frac{5}{6}''$
2	11.00	125	$86\frac{7}{16}$	$211\frac{7}{16}$	$\frac{5}{8}''$
3	11.00	$114\frac{3}{8}$	$86\frac{7}{16}$	$200\frac{10}{16}$	$\frac{9}{16}$
4	11.00	$107\frac{1}{16}$	$84\frac{11}{16}$	$191\frac{12}{16}$	$\frac{1}{2}$
5	11.00	$87\frac{1}{2}$	$84\frac{11}{16}$	$172\frac{3}{16}$	$\frac{7}{16}$
6	11.00	75	$77\frac{5}{16}$	$152\frac{5}{16}$	$\frac{6}{16}$
7	11.00	$56\frac{11}{16}$	$77\frac{5}{16}$	134	$\frac{5}{16}$
8	11.00	$53\frac{1}{4}$	$55\frac{1}{4}$	$108\frac{1}{2}$	$\frac{4}{16}$
9	11.00	50	$55\frac{1}{4}$	$105\frac{1}{4}$	"
10	11.00	50	48	98	"
11	11.00	1	"	"	"
Bearing.	8.00				
	129.00				

BOTTOM PLATES.

1	19.6	137.50	63.75	201.25	$\frac{3}{8}$—$\frac{5}{16}$	Double.
2	14.0	137.50	57.75	195.25	"—"	
3	14.0	125.00	57.75	182.75	"—"	
4	14.0	112.50	54.25	166.75	$\frac{5}{16}$—$\frac{4}{16}$	
5	14.0	87.50	57.50	145	$\frac{4}{16}$—$\frac{3}{16}$	
6	14.0	85.00	33.00	118	$\frac{5}{16}$	
7	14.0	50.00	42.00	92	$\frac{4}{16}$	
8	17·6	50.00	42.00	92	$\frac{4}{16}$	
Bearing.	8	50.00	22.00	92	$\frac{4}{16}$	
	129.0					

SIDE PLATES.

Beginning at the centre, and strengthened by lateral irons inside and out, placed at distances of 3,′ 6″,—

The first space, 35 feet from centre is formed of $\frac{1}{4}$ inch plate.							
The second space of $45\frac{1}{2}$ feet		"		"	$\frac{5}{16}$	"	"
The third	" 35	"	"	"	$\frac{6}{16}$	"	"
The remaining space		"	"	"	$\frac{8}{16}$	"	"

The immediate part of the tube resting on the pier is likewise strengthened by increased lateral bracing.

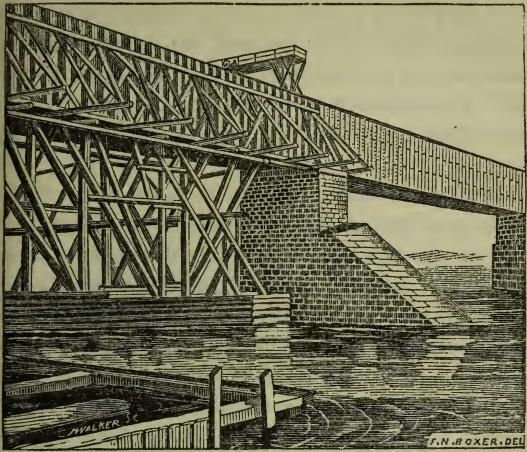
At the line of neutral axis a few small circular holes are perforated in the side of the tube to throw light into the interior.

Over the top of the bridge is constructed a light roof of wood, on the ridge of which is a foot-walk 26 inches wide; and a track is also provided for the painting travellers. The roof is covered with tin; and the frame and tin work are so arranged as not to be injured by the expansion or the contraction of the tubes.

The sides of that portion of the top of the piers on which the tubes do not rest, are covered with iron brackets, which protect the masonry of the pier, and also prevent snow from blowing in through the space left for the expansion of the tubes.

The tubes themselves were constructed in position, and the difficult and expensive process of floating them from the shore and lifting them by hydraulic pressure was thus dispensed with. Where the coffer-dams were in use, the framing was carried up from them; and in the centre, a scow was anchored and piles driven in around it, on which the scaffolding rested. It was here that the difference between the two systems of dams was apparent. In the one three scows secured with piles was necessary; in the other, but one. On these supports a truss was formed on which the tube was put together.

The following wood-cut shows the description of truss ısed for this purpose :



The Expansion Rollers are seven in number in each set, f 6 in. diameter, in a cast-iron frame, rolling on planed ed-plates. The rollers themselves being turned and the beds lated, they run as smoothly as on glass.

Riveting.

The rivets are an inch in diameter, and are arranged in ɔws. They were heated in portable furnaces, which were ıoved from place to place as the work proceeded. From hese forges the rivets were taken up with tongs by one of he boys attending and thrown to the rivetters on the stage bove ; and it was extraordinary to remark with what dexerity and precision these lads would throw the rivets and ıake them curve over the stage and fall to right or to left on ny spot they desired. The rivets were then placed in the

holes punched for them, and the ends firmly clenched with heavy hammers before cooling.

The rivet head, thus formed, is in a rough shape, and is finished by placing a steel cup-shaped tool upon it, which, being struck with a heavy hammer, the head of the rivet becomes formed perfectly smooth and convex in the steel mould. The contraction of the length of the rivet, in cooling, draws the plates close together with considerable force.

It required no small amount of nerve for the inquisitive visitor to pass through the fiery ordeal. As he gradually approached through the dark tube, the hollow sounds of the heavy hammer on the iron plates reverberated from side to side with a thousand echoes on the ear; but when he arrived at the actual scene of work, it would be difficult to describe the feelings of the looker on. The strokes of the hammers no longer had a deep sonorous sound, but fell with a hard and clanging ring upon the ear that threatened to rupture its tympanum—the darkness of the place—the dim glare of the smoky furnaces—the fiery darts shooting around, and the dark and shadowy objects flitting here and there, like spirits of another world, altogether had such a bewildering effect upon the senses, that the classical reader, for a moment, might fancy himself in the reigons of old Vulcan, surrounded by his Cyclops forging the thunderbolts of Jupiter.

In the fall of 1859, the last tube of this wondrous work was completed; and on the 17th December of the same year, Mr. J. Bruce and Mr. P. Stockman, Civil Engineers, who were sent out from England, at the desire of Mr. Stephenson before his death, to test the strength of the tubes and to examine the work, made their formal report; part of which will be found in the appendix.

The reader, as he has stood on the banks of the St.

wrence, and admired the noble Bridge which crosses
er the immense volume of water flowing onwards to the
ean, and wondered at the talent and genius of the men
o conceived, designed, and carried out so stupendous a
rk, when so many difficulties had to be encountered,
l probably think for what great purpose has so immense a
n of money been expended in its construction. Was it
ambition, pride, or folly of the Colony to eclipse the
ole world in this Titanic structure? or did it
anate from the wisdom of its people, who considered
construction absolutely necessary for the completion of
ae great national and commercial policy?

There are some nations, who, though blessed with a
l of the greatest fertility, with a climate of the most ge-
l description, and with resources, which, if developed,
uld render them the richest, happiest, and most power-
of people, yet, from their natural supineness and con-
utional indolence, have no desire to cultivate and im-
ve the rich gifts so bounteously bestowed upon them by
ure, nor the energy to become great and powerful.

How different is the character of the Anglo-Saxon and
ench races! No matter in what part of the world they fix
ir abode, or what difficulties they have to encounter,
ir progress is ever marked by rapid civilization, pros-
ity, and wealth. Success seems to follow in their footsteps.
all the British Colonies which now or once belonged
the English realm, may be seen the striking contrast
ween the Anglo-Saxon and other nations of the earth;
l the same remark may be now applied to the people of
ance.

From the date that Jacques Cartier first landed on the
res of Canada in 1554, up to 1760, there was a period
almost incessant warfare between the brave French
lers and the aborigines of the country; the latter fre-

quently assisted by British troops. During the period o these early struggles, little progress could be made either i civilization or agricultural improvements: it was as much a the hardy French adventurers could accomplish to hol their ground against a fierce, savage, and implacable foe But a century and a half by-gone, in this same city, now so flourishing and adorned with costly edifices, and whos streets, in a few short weeks, will be thronged with thousand of strangers assembled from different parts of this Conti nent to witness the celebration and the inauguration of th greatest engineering work in the world, by the heir of Bri tain's Throne; yes, reader, in this city—now so fair an happy, but then consisting of but a few straggling house surrounded by a rude fortification—did 1200 warriors o the Iroquois tribe make a sudden descent, and 1000 o the brave French settlers fell under the tomahawk and th scalping-knife of the ruthless savage. Mother and infan met with no mercy from the fiend-like foe, who savagel killed, burnt, destroyed, and laid waste all around, carryin off twenty-six of their captives to meet a still more horri ble death by torture at the stake.

Nor did the horrors of war cease with the ceding of thi Colony to the British Crown. In 1775 commenced th struggle of the American Colonies for their freedom; an from that date until 1814, the blood of many a brav Canadian stained the soil in loyally fighting for the Crow of England.

But though peace had at last found a resting-place o the soil of Canada, yet years passed away before any re action took place after so long and desolating a war; an even thirty years ago, Montreal was thus characterized b an American writer:—

"The approach to Montreal conveyed no prepossessing idea o the enterprise of its municipality. Ships, barges, and steamboat

y on the margin of the river, at the foot of the hill. No line of iarves built of substantial limestone, of which there is abun-nce in the neighbourhood, afforded security to vessels and own-s. The commercial haven looked as ragged and muddy as the ores of New Nederland when the Guedevrow first made her pearance off the Battery."

Nor was the progress of other Canadian cities at all remark-le; as a well-known writer in this city has thus described e state of Canada a few years back:—

"Then no great chain of railway linked town to town and y to city, almost annihilating distance. Then the journey to To-nto was a toilsome matter of weeks; and that to Brockville, rt even as is the distance, occupied, with heavy cumbrous *teaux*, three weeks. Now how changed! The wand of some ry king has surely been here. But no! Industry, intelligence, our, capital, all combined, and working for the advancement this rising Colony, have produced the marvellous changes ich meet us on every hand."

To the effect of the onward movement of immigration a hardy, enterprising, and persevering race, the infusion new blood, and the changes brought about in the admin-ation of the affairs of the Province, may mainly be at-uted the unprecedented prosperity of Canada in so rt a period, far exceeding that ever recorded in the an-s of the history of any country. Montreal in 1843 tained about 45,000 inhabitants; it now nearly doubles number. In 1842 Toronto contained but 13,000 ple; its population now is close upon 50,000. King- in ten years doubled its inhabitants, and London in year added 30 per cent to its number, whilst a corre-nding increase took place in almost every town in Upper ada. Ottawa, soon to be the future capital of Canada, ained in 1830 but 150 houses; it now has a population bout 14,000. The farm on which the city now stands was chased but a few years ago for £90; and it is even

stated that the proprietor, who is still living and said to be immensely wealthy, afterwards most bitterly regretted his bargain, little dreaming that in so short a space of time a city would be built upon its rocky surface.

The great agricultural resources of the country were rapidly becoming developed; and although, through the foresight of Government, spacious canals and other expensive public Provincial works were constructed for the advancement of her prosperity, still the rigour of the climate, which, during six months in the year, closed up her ports, rendered it impossible for her to cope with her powerful, ever-active, and enterprising neighbours, unless some means of transit were afforded, direct to the open sea, during the period that the navigation of the St. Lawrence was impeded.

We need not enter into the details of the establishment of the great Canadian system of railroads. The remedy to the disadvantages under which this Colony labored was to be found only in their construction. The credit of the Province was pledged, English capital was obtained, and Canada is no longer isolated during the long period when nature throws an icy warp over her deep broad rivers and inland seas. The connecting link to this great chain of railway was, however, still wanting; but that now is accomplished, for the Victoria Bridge links Canada's prosperity with that of the wide world, and all the benefits that will accrue to the Province from her great Bridge and Railways, however dear she may have paid for them, is yet to come: it is but the beginning of the end. The traffic that has passed over the line has considerably increased since the bridge has been finished; and some idea may be formed of its advantages when we mention, that, in five nights after trains could run through the bridge, 292 cars passed through, containing 11723 barrels flour, 1552 barrels

ork, 140 bales of cotton, 644 tons general goods, 170 ons iron, and 39,000 feet of lumber.

Facilities for the transmission and the delivery of freight e now afforded by the Grand Trunk Railway unequal-d by any other line; it having but one trans-shipment tween Cincinnati or Chicago and the Eastern States, d none between the west of Canada and the same places. one direction, easterly, its line extends from Portland, in aine, to Quebec and to Riviere du Loup, in Lower nada; and will doubtless soon be connected with Hali-x, in Nova Scotia: whilst in Upper Canada, it extends, a westerly direction, to London, Detroit, and Michigan; ssing through Montreal, Brockville, Kingston, Belleville, bourg, Port Hope, Toronto, Guelph, and Sarnia, and nnecting with the other railways in Canada. The day may not be far distant when this line of railway will ch the shores of the Pacific Ocean. What will be the eficial result to Canada, time alone will tell; but, judg- from the past, if her prosperity goes on increasing with facilities offered for opening up the country, for extend- its commerce, and developing its resources, it will be at indeed.

In concluding these remarks, it may not be uninterest- to the general reader to hear of the incidental occur-ces which took place during the construction of the toria Bridge, copied partly from the *Montreal Gazette.* course, the laying of the first stone was the primary event onnection with its construction. This took place on the July, 1854.

The coffer-dam for No. 1. pier having been floated into place, sunk, water pumped out, and all made right and t, the principal officers of the Company, Sir Cusack P. ey, Managing Director; Benjamin Holmes, Esq., Vice sident; Hon. Peter McGill, Alex. McK. Ross, Chief

Engineer; Mr. Grant, Assistant Secretary; S. P. Bidder, Esq., Manager; the representatives of the City Press, and a large party of ladies and gentlemen were present at the ceremony, at the invitation of Mr. Hodges, the Agent of the Contractors.

The party having descended to the bottom of the coffer-dam, the stone was laid with all the ceremony used on similar great occasions. After the ceremony, the guests partook of a sumptuous luncheon served up in the bottom of the dam, which was followed up by a dance, and the "gruff old St. Lawrence never had its bed kicked about by a happier set of people." Just as the festivities concluded, a heavy thunder-storm commenced; as if old Vulcan was testifying his anger at the commencement of a work that was to eclipse all that had ever been wrought by his heathen deityship, with his black Cyclopean crew, in the forges of Mount Ætna.

On the 13th of March, 1856, a great celebration took place in Montreal to commemorate the completion of the Grand Trunk Railway to Toronto. It was indeed a gala time.

At an early hour the streets presented a most animated appearance. Bright coloured flags gracefully floated from the windows and the house-tops, or were suspended across the streets. The streets were crowded with strangers. Every window was crowded with the fair sex, who looked down with delight on the grand procession slowly moving along in the streets below, the effect of which was very striking.

In the evening, a banquet and ball was given at Point St. Charles, in one of the immense rooms connected with the Engine Station. The room was beautifully and tastefully decorated. The rafters were adorned with Cupids holding vases of flowers pendant from the roof, and surmount-

ed by the flags of Britain, France, and the United States. Between each pair of pilasters, along the sides, were suspended the names of cities, alternated with the names of celebrated men.

On each alternate pilaster the monogram of the Grand Trunk Railway was intertwined ; on the others were shields displaying the flags of Sardinia and Turkey ; and stretched along this was the motto," Success to Mercantile Enterprise, Railways, Telegraphs, and Ocean Steam-Ships." Below these shields was a view of the Grand Trunk Railway Bridge over the River Credit. On one side of this, was placed the motto " Better do it than wish it to be done ;" and on the other side, " Magnanimity is the bond of friendship." At the other end of the room was displayed a railway trophy surrounded by green boughs, having in the centre a view of the Victoria Bridge supported by railway and mechanical implements, and figures emblematic of agriculture and mechanics. On the right were observed the mottoes " God helps them who help themselves," and " Past labour is present delight." In the centre of the room was placed the *dias* for distinguished people and speakers; and from the roof, over the *dias*, was suspended a beautifully emblazoned shield, bearing the arms of the Governor General, draped with the flags of Britain and the United States, with the mottoes " Few things are impossible to skill," " Industry is never unfruitful," " Business is the salt of life," " Men climb to honor by prudence and industry." Opposite, was the orchestra, prettily painted in panels surmounted by pendant bouquets. Over it were displayed the mottoes " That is gold which is worth gold," " Deeds are fruits," " Words are but leaves." The whole sides of the room were hung with garlands of green boughs twisted, interlaced, and looped up with pretty fastenings upon the buttresses.

The *coup d'œil* on entering was really magnificent. Th whole area of 34,000 square feet, unbroken by any obsta cle to sight, sparkled and glittered with decoration ; whil the otherwise sombre hue of the heavy timbers of the roof was broken by the sky-light running along the ridge, fo several feet on either side, giving the whole a fine an equally diffused light.

When the guests were seated, the effect was grand giving one a distinct conception of the term often, an sometimes so magniloquently used as a "sea of faces."

It were needless to mention here the names of all th principal parties who sat down to the Banquet. Amongs the most prominent was His Excellency the Governo General ; the Anglican Lord Bishop of Montreal, beside all the notables of the Province, and from every part of th United States. Various toasts were given and responde to ; and the observations that fell from the lips of some o the distinguished men on this occasion deserve to be men tioned.

His Excellency the Governor General, Sir Edmun Head, said :—

"He felt assured that the celebration was one which th future historian would look back at with satisfaction : it woul make a bright page in the history of Canada. It was in 183 that Lord Durham made his Report on Canada, and how did h describe it ? He stated, that, except in a few spots, the countr was *wild* and *desolate*. But now what was the condition o Canada ? The country produced not only enough to supply ou own needs, but exported to the United States, and to Europe and all this progress had been made in 17 *years*. Since Lor Durham wrote his Report, instead of the 15 miles of railwa that then existed, there were nearly 1500 miles open. The whol country is now opened up, and the markets of Europe rendere accessible to the people. The former tedious journey from Quebe to Montreal was now performed in five or six hours ; and the traveller might go from one end of the Province to the other in 24

hours. The Victoria Bridge would render Montreal famous for one of the most wonderful works in the world. His Excellency then alluded to the Victoria Bridge, connecting the splendid and rich valley of the Ottawa with the South."

Senator Wilson, of Massachusetts, in returning thanks for the health of the President of the United States, said :—

"We witness the prosperity of the British Colonies in North America, not only without jealousy, but we witness it with pride and admiration. Your prosperity is our prosperity. We are bound by a thousand associations of blood and kindred. We are connected together by those mighty improvements which we are met here to day to commemorate. We are beginning to understand each other, to value each other, to be proud of each other's prosperity and success; and God grant that the sons of British North America and the sons of the North American Republic may never meet again on the banks of the St. Lawrence, on river or lake, on land or in any other way, than that in which we are all met to-day, to grasp each other's hands in friendship, and to aid and to encourage each other in the development of the resources of the North American Continent."

Colonel Taché also spoke to some length. He remarked :

"I will admit that a few years back I was one of the unbelievers. I never thought that this great work we are now called upon to celebrate to-day, would be seen by the present generation ; but that it would be the lot of future generations to see it. I thought so, because there were so many obstacles, so many difficulties, in the way."

Four thousand guests sat down to this great banquet, who were invited to it from all parts, from the Mississippi on the West to Newfoundland on the East.

On the 15th August, 1859, was laid the foundation-stone of the last pier of the Victoria Bridge. Some 300 ladies and gentlemen were present at the ceremony, besides the members of the City Council, Board of Trade, and leading citizens of Montreal. The stone was laid by Mrs. Hodges, who performed the duty with feminine graceful-

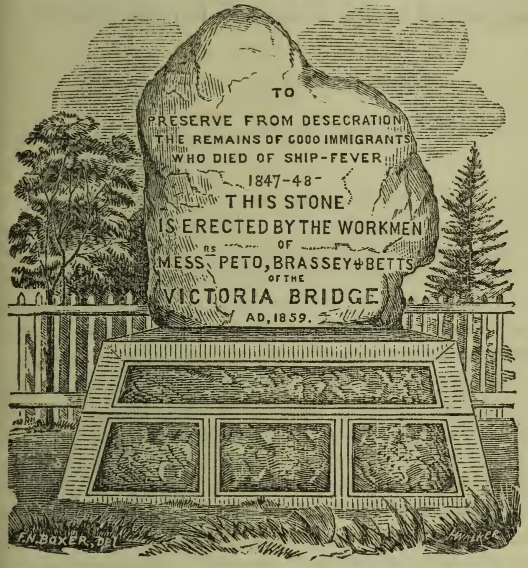
ness. It was slowly lowered down into, almost what ma be said to be, its eternal bed, amidst the cheers of all pr sent. The foundation-stone of this pier, which is one c the two large centre piers, was laid upwards of thirty fee below the level of the river, on a bed of solid rock. M Ross, chief engineer, stated that "upwards of 3,000,00 cubic feet of limestone was used in the work; and whe you consider that the period of our labour is restricted, i each season, to an average of 100 days, reckoning each da at 10 working hours, or 1,000 hours in a year, it shew that we have laid 500,000 feet each year, equal to 5,00 feet per day, or, coming down lower still, 500 feet per hou You will thus find that we have performed an amount c work unequalled by any previous work of art in the world.'

To witness the ceremony was indeed an event in a man' life, and bits of the rock were carried off by many wh witnessed the laying of the foundation-stone of the las pier of the great Victoria Bridge.

One more event must be mentioned, illustrative o kind and sympathetic hearts in the bosoms of the mechanic and workmen under the employ of Mr. Hodges. On the east side of the embankment of the Victoria Bridge, a Point St. Charles, is a spot of ground which was set aside by the Provincial Government for the interment of immigrants. In this burial-ground are deposited the remains of upwards of 6000 human beings, the victims of that pestilential fever which, in 1847-48, carried off whole families of immigrants who had fled from the famine and the pestilence that was raging in their native land, only to die upon their arrival on a foreign shore, without a friend, perhaps, to close the eyes, soothe the sufferings of the dying, or to shed a tear over the unmarked grave of the poor immigrant

Actuated with the noble feeling that all men are brethren, the *employés* of Mr. Hodges, to commemorate their sad

ad unhappy fate, and to point out to the passing stranger ieir last resting-place, placed in the burial-ground large boulder taken out of the foundation of one of ie piers, weighing over 17 tons, of which the following, ith its appropriate inscription, is an illustration:



Reader, we have endeavoured to give a sketch of the story of the great Victoria Bridge, but we feel how inaequately has the task been accomplished. The man of ience will feel disappointed that these pages are so barn of scientific matter; but we have reason to hope that a rge work of great merit, will, ere long, be published in ngland by one who built the Bridge.

There is, however, a moral in its history, a practical lustration, that when great ideas are conceived by men of

sense, however impraticable they may appear to the mu
titude at first, learn not to despise them. The greatest di
coverers that the world has ever known, have been laughe
at as fools, or treated as madmen; and the Victoria Bridg
would not at this day have been built across the gre
river St. Lawrence, had those who conceived the idea bee
weak minded enough to succumb to public opinion.

APPENDIX.

REPORT OF ROBERT STEPHENSON.

To the Chairman and Directors of the Grand Trunk Railway Company of Canada.

Gentlemen,—Having learnt that some doubts have been expressed respecting the fitness of the designs for the Victoria Bridge across the St. Lawrence at Montreal,—that it is more costly than necessary, and that other systems of structure less expensive, yet equally efficient, might with propriety be adopted, —I feel called upon to lay before you in some detail the considerations which influenced me in recommending the adoption which is now being carried out. In doing so, I beg to assure you that the subject was approached in the outset, both by Mr. Alexander Ross, your Engineer in Canada, and myself, with a thorough consciousness of the enormous expense which must inevitably be involved, whatever description of structure might be adopted; also of the large proportion which this cost must bear to the entire outlay of the undertaking of the Grand Trunk Railway of Canada. We were, therefore, fully alive to the imperative necessity of studying the utmost economy in every part of the work, consistent with our notions of efficiency and permanency.

It will be my endeavour, in the following remarks, to satisfy you and those interested in the undertaking, that these object, have been steadfastly kept in view.

It would evidently be unreasonable to expect, that, amongst professional men, an absolute identity of opinion should exist, either in reference to the general design, or in many of the details, of a work intended to meet such unusually formidable

natural difficulties, as are to be contended with in the construction of a bridge across the St. Lawrence.

You will remember that at the time I first entered upon the consideration of the subject, these difficulties were deemed by many well acquainted with the locality and publicly stated by them, to be, if not insurmountable, at all events of so serious a character as to render the undertaking a very precarious one.

The information I received respecting these obstacles, when my attention was first drawn to this project, was so striking, that I reserved forming an opinion until I had visited the spot, had well considered all the detailed information which Mr. Alexander Ross had collected, during several months' previous residence in the country ; and had heard the opinion of many intelligent residents regarding the forces exhibited by the movements of the huge masses of ice during the opening of the river in spring.

The facts gathered from these sources fully convinced me, that, although the undertaking was practicable, the forces brought into action by the floating ice, as described, were of a formidable nature, and could only be effectively counteracted by a structure of a most solid and massive kind.

All the information which has been collected since I made my first report, has only tended to confirm the impressions by which I was then guided.

For the sake of clearness and simplicity, the consideration of the design may be divided into four parts :—first, the approaches; secondly, the foundations ; thirdly, the upper masonry ; and, fourthly, the superstructure, or roadway.

The approaches,—extending in length to 700 feet on the south or St. Lambert side, and 1300 feet on the Point St. Charles side,—consist of solid embankments, formed of large masses of stone, heaped up and faced on the sloping sides with rubble masonry. The up-stream side of these embankments is formed into a hollow shelving slope, the upper portion of which is a circular curve of 60 feet radius, and the lower portion, or foot of the slope, has a straight incline of three to one, while the down-stream side, which is not exposed to the direct action of the floating ice, has a slope of one to one. These embankments are being constructed in a very solid and durable manner, and from their extending along that portion of the river only, where

ıe depth at summer level is not more than two feet six inches ; ıe navigation is not interrupted, and a great protection is, ; their means, afforded to the city from the effect of the shoves" of ice which are known to be so detrimental to its ontage.

For further details on this subject, I beg to refer you to the eport made by Mr. Ross and myself on the 6th of June, 1853, the Honourable the Board of Railway Commissioners, Quebec.

Advantage has also been taken of the shallow depth of water constructing the abutments, which are each 242 feet in length, ıd consist of masonry of the same description as that on the piers hich I am about to describe, and, from their being erected in ıch a small depth of water, their foundations do not require ıy extraordinary means for their construction.

The foundations, as you are aware, are fortunately on solid ck, in no place at a great depth below the summer level of the ater in the river.

Various methods of constructing the foundations suggested emselves and were carefully considered, but, without deciding ɔon any particular method of proceeding, it was assumed that e *diving-bell*, or such modifications of it, on a larger scale, as ıve been recently employed with great success in situations ɔt very dissimilar, would be the most expedient. The Conactors, however, or rather the Superintendent, Mr. Hodges, in ɔnjunction with Mr. Ross, after much consideration on the ot, devised another system of laying the foundations, which as by means of floating "coffer-dams," so contrived that the ual difficulty in applying coffer-dams for rock foundations ould be, it was hoped, in a great measure obviated. When in ɔntreal, I examined a model of this contrivance and quite ɔproved of its application, without feeling certain that it ɔuld materially reduce the expense of construction below that the system assumed to be adopted by Mr. Ross and myself in aking the estimate. In approving of the method proposed by r. Hodges, I was actuated by the feeling that the Engineers ould not be justified in controlling the Contractors in the loption of such means as they might consider most economical themselves, so long as the soundness and stability of the ɔrk were in no way affected.

This new method has been hitherto acted upon with such

new modifications as experience has suggested from time t time during the progress of the work, and although successfully I learn from the Contractors that experience has proved the be of the river to be far more irregular than was at first supposec —presenting, instead of tolerably uniform ledges of rock, larg loose fragments which are strewed about, and cause much incon venience and delay.

They are therefore necessitated to vary their mode of prc ceeding to meet these new circumstances ; and it may be state that all observations up to this time show the propriety, no withstanding the difficulty with dams, of carrying the ashla masonry of the piers down to the solid rock, and that an attempt at obtaining a permanent foundation by means of con crete confined in " caissons " would be utterly futile. Howeve if it were assumed to be practicable, there would be extrem danger in trusting such a superstructure of masonry upon con crete, confined in cast-iron caissons above the bed of th river. Indeed, considering the peculiarities of the situation an the facts which have been ascertained, this mode of formin foundations is the most inappropriate that can be suggested, a it involves so many contingencies, that to calculate the extrem expense would be utterly impossible.

These considerations lead me, therefore, to the conclusio that the present design for the foundation is as economical a is compatible with complete security.

We are now brought to the question, as to whether the uppe masonry is of a more expensive description than necessary, o whether it can be reduced in quality. This question is exceed ingly important, since the cost of the masonry constitute upwards of 50 per cent. of the total estimated cost of the bridg and approaches. The amount of the item of expenditure fo the masonry is clearly dependent upon the number of piers which is again regulated by the spans between them.

The width of the openings in bridges is frequently influenced and sometimes absolutely governed, by peculiarities of sit In the present case, however, the spans, with the exception c the middle one, are decided by a comparison with the cost of th piers ; for it is evident that so soon as the increased expense i the roadway, by enlarging the spans, balances the economy pro

luced by lessening the number of piers, any further increase of span would be wasteful.

Calculations, based upon this principle of reasoning, coupled to some extent with considerations based upon the advantages to be derived from having all the tubes as nearly alike as possible, have proved that the spans which have been adopted in the present design for all the side openings, viz. 242 feet, have produced the greatest economy. The centre span has been made 330 feet, not only for the purpose of giving every possible facility for the navigation, but because that span is very nearly the width of the centre and principal deep channel of the stream.

The correctness of the result of these calculations obviously depends upon the assumption, that the roadway is not more costly than absolutely necessary ; for if the comparison be made with a roadway estimated to cost less than the tubular one in the design, then the most economical span for the side openings would have come larger than 242f eet, and the amount of masonry might have been reduced below what is now intended. In considering the quantity of masonry in the design, you must, therefore, take it for granted, for the moment, that the *tubular roadway* is the cheapest and best that could be adopted, and leave the proof of this fact to the sequel of these remarks.

It may perhaps appear to some in examining the design, that a saving might be effected, in the masonry, by abandoning the inclined planes which are added to the up-side of each pier, for the purpose of arresting the ice, and termed "ice-breakers."

In European rivers, and I believe in those of America also, these "ice-breakers" are usually placed a little way in advance of, or rather above, the piers of the bridges, with a view of saving them from injury by the ice shelving up above the level of (frequently on to) the roadway.

In the case of the Victoria bridge, the level of the roadway is far above that to which the ice ever reaches ; and as the ordinary plan of "ice-breakers" composed of timber and stone would be much larger in bulk, though of a rougher character, than those which are now added to the piers, I have reason to believe that they would be equally costly, besides requiring constant annual reparation. It was therefore decided to make them a part of the structure itself, as is now being done.

To convey some idea of the magnitude of ordinary "ice-break-

ers" placed on the up-side of the pier, and to enable you t form some notion of their cost, I cannot do better than quote th following from the excellent report addressed to the Honorabl John Young, by Mr. Thomas C. Keefer, whose experience in suc matters, from long residence in the country, entitles his opinio as to the proper character of such works to confidence :

"The plan I have proposed contemplates the planting of ver large "cribs" or wooden "shoes," covering an area of abou one fourth of an acre each, and leaving a clear passage betwee them of about 240 feet,—a width which will allow ordinary raft to float broadside between them. These "islands" of timber an stone, will have a rectangular *well* left open in the middle o their width, toward their lower ends, out of which will rise th solid masonry towers, supporting the weight of the superstruc ture, and resting on the rocky bed of the river. This enclosur of solid crib-work, all round the masonry, yet detached from it will receive the shock, pressure, and grinding of the ice, an yield to a certain extent, by its elasticity, without communicat ing the shock to the masonry piers. These cribs, if damaged can be repaired with facility, and, from their cohesive powers will resist the action of the ice better than ordinary masonry During construction, they will serve as coffer-dams, and, bein formed of the cheapest materials, their value as service-groun or platforms for the use of machinery, the moving of scows, &c. during the erection of the works, will be at once appreciated Their application to the sides of the piers is with particular refe rence to preventing the ice from reaching the spring of the arche which will be the lowest and most exposed part of the super structure, if wood be used."

In the first design for the Victoria bridge, "ice-breakers" very similar to the above described by Mr. Keefer were intro duced ; but subsequently the arrangement was changed, partl with a view of gaining the assistance of the whole weight o the bridge to resist the pressure of the ice, before it becam fixed, and partly for the purpose of obviating the considerabl annual outlay.

I have not data at hand to estimate correctly the cost of the ordinary "ice-breakers" as described ; but I have little or no doubt, that, as I before stated, they would have required to have been large and substantial masses of stone and timber, which

amount of cost would be scarcely less than, if not equal to, ; inclined planes of masonry which have been added to the side of the piers. On this point, however, as well as upon ıers in reference to some reduction in the quantity of masonry the piers and abutments, I intend to address Mr. Ross, who ng on the spot will be able to determine with more accuracy ın I can the amount of actual saving which can be effected the masonry.

[t is now necessary for me to say a word or two upon the le of the workmanship. It consists simply of solid ashlar; l considering the severe pressure and abrasion to which it l be subjected by the grinding of the ice, and the excess-ly low temperature to which it will for months be periodi-ly exposed, I am confident that it is not executed with more idity than prudence absolutely demands; and considering difference of the rates of wages in Canada and this country, elieve the price of the work will come out nearly the same any similar work let (here) by competition.

[he description and style of the masonry is precisely similar that adopted in the Britannia Bridge; the material is the ıe, and the facility of obtaining it is not in any important gree dissimilar.

[he next point to be discussed is the construction of the su-structure, or roadway; and here, owing to the misconcep-ı which seems to exist on this subject amongst some Engi-rs, I am compelled to enter somewhat into technical details eference to the treatment and construction of beams.

[he matter has already been debated before the Institution Civil Engineers, at great length, arising out of a paper read Mr. Barton on the construction of the bridge over the river yne, erected under the direction of Sir John Macneill.

n the design of this bridge the Engineer has adopted what echnically termed the "Trellis" system of beam or girder, the avowed purpose of saving material, as compared with plain tubular system adopted in the Britannia, and now pro-ed for the Victoria Bridge.

: has been already stated that the design and the cost of mason-materially depend upon the comparative expense which may ncurred in the construction of the Roadway, since the spans openings adopted are really governed by this item in the

estimate. It is, therefore, doubly necessary that this part the proposed design should be analyzed with care.

Notwithstanding the discussion which took place at the stitution of Civil Engineers, as to the comparative merits constructing beams in almost every variety of detail, it c tainly appears, as far as I am able to form a judgment, t much error still prevails regarding the simple principles t should, and indeed must govern the arrangement of every bea bridge.

The tubular system is openly declared by some to be a was ful expenditure of material for a given strength ;—in short, th in the scale of comparative merit, it stands at the lowest poi This, if it were the fact, would not be extraordinary, since was the first proposed for carrying railways over spans never fore deemed practicable ; but in the following remarks I ho to convince you, in the simplest manner, that (except in par cular cases) whilst it is not a more costly method of constru tion, it is the most efficacious one that has hitherto been vised.

At present there mny be regarded as existing three metho of constructing wrought-iron girders or beams for railway pu poses.

First.—The *Tubular Girder*, or what is sometimes called t *Box-Girder*, when employed for small spans, with which m also be named the *Single-ribbed girder*,—the whole belonging the class known as "*Boiler-plate*" girders.

Second.—The *Trellis-Girder*, which is simply a substituti of iron bars for the wood in the trellis-bridges, which have be so successfully employed in the United States, where wood cheap and iron is dear.

Third.—The *Single triangle girder*, recently called "Warre from a patent having been obtained for it by a gentleman that name.

Now in calculating the strength of these different classes girders, one ruling principle appertains, and is common to of them. Primarily and essentially the ultimate strength considered to exist in the top and bottom,—the former bei exposed to a compressive force by the action of the load, a the latter to a force of tension ; therefore, whatever be the cla or denomination of girders, they must all be alike in amount

ective material in these members, if their spans and depths the same, and they have to sustain the same amount of d.

On this point I believe there is no difference of opinion ongst those who have had to deal with the subject. Hence, n, the question of comparative merits, among the different sses of construction of beams or girders, is really narrowed the method of connecting the top and bottom *webs*, so called. the tubular system, this is effected by means of continuous tes riveted together ; in the trellis girders, it is accomplished the application of a trellis-work, composed of bars of iron ming struts and ties, more or less numerous, intersect- each other, and riveted at the intersections ; and in girders of the simple triangular, or "Warren" system, the nexion between the top and bottom is made with bars,—not ersecting each other, but forming a series of equilateral tri- gles. These bars are alternately struts and ties.

Now in the consideration of these different plans for connect- the top and bottom *webs* of a beam, there are two questions be disposed of; one is, Which is the most economical? and other, Which is the most effective mode of so doing? But ile thus reducing the subject to simplicity, it is of the utmost portance to keep constantly in mind, that any saving that the system may present over the other, is actually limited to a tion, or per centage, of a subordinate part of the total ount of the material employed.

n the case now under consideration, namely, that of the ctoria tubes, the total weight of the material between the rings is 242 tons, which weight is disposed of in the following nner :—

Top of Tube,.................. tons	76	
Bottom of Tube,................	92	
		158
Sides of Tube,.......		84
Total tons, ...		242

suming that the strain per square inch, in the top and bot- n, is the same for every kind of beam,—say 4 tons of com- ssion in the top, and 5 tons of tension in the bottom,—the y saving that can by any possibility be made to take place

being confined to the sides, must be a saving in that portion the weight which is only about 34 per cent of the whole. Ho therefore, can 70 per cent of saving be realized, as has be stated, out of the total weight, when the question resolves its into a difference of opinion on a portion which is only 34 p cent of such weight?

I am tempted to reiterate here much that was said by seve experienced Engineers on the subject, during the discussio already allude to, at the Institution of Civil Engineers; but t argument adduced on that occasion could only be render thoroughly intelligible by the assistance of diagrams of so complexity, and I think sufficient has been said to demonstra that no saving *of importance* can be made in the constructi of the roadway of the Victoria Bridge, as it is now designed the substitution of any other description of girder. Yet, le this should be considered mere assertion, permit me to addu one or two examples, where the close-sided tubular system, a the open-sided system, may be fairly brought into comparis with each other in actual practice.

The most remarkable parallel case which occurs to me, the comparison of the Victoria tubes under consideration, wi a triangular, or "Warren" bridge, which has been erected Mr. Joseph Cubitt, over a branch of the river Trent, near Newar on the Great Northern Railway.

The spans are very similar, and so are the depths. In callin your attention to the comparison, you must bear in mind th all possible skill and science were brought to bear upon eve portion of the details of the Newark-Dyke Bridge in order reduce the total weight and cost to a minimum.

The comparison stands thus :—

VICTORIA BRIDGE AS BEING ERECTED.

Span, 242 feet; weight, including bearings, 275 Tons for a length of 257 feet.

NEWARK-DYKE BRIDGE AS ERECTED.

Span, 240 feet, 6 inches; weight, including bearings, 392 Tons for a length of 254 feet.

Which shews a balance of 17 tons in favor of the Victoria tube

The Newark-Dyke Bridge is only 13 feet wide, while th Victoria tube is 16 feet, having a wider-guage railway passin through it.

is is a very important case, as the spans and the depths are all identical, and it will therefore enable you to form a judg-t upon that point which has caused so much controversy at discussion alluded to. It is true that in the Newark-Dyke ge a large proportion of the weight is of cast-iron, a mate- I have frequently adopted in the parts of tubular bridges ect to compression only, but from its brittle character I ld never recommend it for exportation, nor for the parts of ucture that are liable to a lateral blow.

has been suggested that there is much convenience in the ngement of the trellis, or "Warren" bridge, as it may be n to pieces, and more conveniently and economically sported over-land than "Boiler-plates." This may be cor- under some circumstances, but it cannot hold good for a k like the Victoria Bridge over the St. Lawrence.

am aware that girders upon the "Warren" principle have adopted in India, and I am not prepared to call in question propriety of these applications in certain cases; but what I been aiming at in these observations, is, to prove to you no economy over the plain tube can be effected in the case e Victoria Bridge. I may add, that it has sometimes been d that the workmanship in trellis, or "Warren" girders, is less expensive character than that required in tubes. I am d to confess my utter inability to understand such a state-t; for, after many years of practical experience as a manu-rer of iron work of every description, I do not know any of workmanship that bears so small a proportion to the e of the material as boiler-plate work. If there be any rence in the cost, it ought certainly be in favor of tubular as.

nother example may be mentioned of a tubular beam, what similar in dimensions to the last described, and one h is actually erected on a continuation of the same line ilway as that on which the Newark-Dyke Bridge is situ-; namely, over the river Aire at Ferry Bridge. Although imilarity is not so great with this as with the Victoria tube, believe it is sufficiently so to form another proof that the ntage is in favor of the solid side.

before :

NEWARK-DYKE BRIDGE.

Span, 240 feet, 6 inches; weight, 292 tons.

FERRY BRIDGE.

Span, 225 feet; weight, 235 tons.

The difference between these weights is more than sufficient t compensate for the difference of span; besides which, in th Ferry bridge, made according to my designs and instructions, was lavish in the thickness of the side-plates, and the bearing which are included in the above weight were stiffened b massive pillars of cast iron.

For a further example, let me compare the Boyne trelli bridge (held by some to be the most economical) with the pre sent Victoria tubes.

The Boyne bridge has three spans, the centre one being 26 feet, and the height is 22½ feet. It is constructed for a doubl line of way, and is 24 feet wide. The total load, includin the beam itself, the rolling load at two tons per foot, and plat form rails, &c., amount to 980 tons, uniformly distributed.

The bridge is constructed upon the principle of "continuou beams," a term which signifies that it is not allowed to take natural deflection due to its span; but being tied over the pier to the other girders, the effective central span is shortened t 174 feet. In fact, this *principle* changes the three spans int five spans. Now the effective area given for compression i this centre span is 113½ inches, which gives a strain for the 17 feet span of nearly 6 tons to the inch in comparison.

The Victoria tubes are so dissimilar in form and circumstance to the Boyne bridge, that it is a troublesome matter to reduc the two to a comparative state. However, the Victoria tube are known to be 275 tons in weight, 242 feet in span, and o 19 feet average depth, the strain not being more than 4 tons pe inch for compression, with a uniform load of 514 tons, whicl includes its own weight, sleepers and rails, and a rolling loa of one ton per foot.

The Victoria Bridge has not been designed upon the principl of continuous beams, for practical reasons, including the circum stance of the steep gradient on each side of the centre span and the great disturbance which would be caused by the accu mulated expansion and contraction, of such a continuous system of iron-work, in a climate where the extremes of temperature

so widely apart; otherwise the principle alluded to, was developed in tubular beams, namely in the Britannia bridge. it since we are only now discussing the merits of the sides, he Boyne bridge be supposed to have sufficient area in its to resist 4 tons per inch (the proper practical strain), and he spans be not continuous. It will be found by calcula- that the area required at top will be 364 inches, instead of inches, and the weight of the span would be found by cal- tion to come out little short of 600 tons; whereas it is now tons; and if we suppose the Victoria tube to carry a double of *way* and 24 feet wide with a depth of 22½ feet, even if louble the size in quantity, the whole amount of weight will ertainly very little more than 500 tons for 242 feet span.

will be necessary to conclude my remarks with some fur- observations relative to the comparisons under our notice, h are of vital importance in considering the design of such dge as that to be erected for the Grand Trunk Railway of ada.

dependently of the comparative weights and cost, which I ve have been fairly placed before you, the comparative ts as regards efficiency have yet to be alluded to.

u may be aware, that, at the present time, theorists are at variance with each other as to the action of a load in ning a beam in the various points of its depth; and the fact w known, that all the received formulæ for calculating strength of a beam subjected to a transverse load require odelling; therefore, at present it is far beyond the power of designers of *trellis* or *triangular* bridges to say with pre- n what the laws are which govern the strains and resis- es in the sides of beams, or even of *simple solid beams;* yet thing is certain, which is, that the sides of all these trellis Warren" bridges are useless except for the purpose of con- ing the top and the bottom and keeping them in their proper tion. They depend upon their connection with the top and m webs for their own support; and since they could not in their shape but collapsed immediately they were dis- ected from these top and bottom members, it is evident they add to the strain upon them, and consequently to extent reduce the ultimate strength of the beams.

the case of the Newark Dyke Bridge, when tested to a

strain of 6¾ tons to the inch, its deflection was 7 inches in t middle; and when tested with its calculated load of one ton p foot run, the deflection was 4⅝ inches. The deflection of t Victoria tubes by calculation will not be more, with the load one ton per foot, than $\frac{1}{6}$ inch; and we have had sufficie proof of the correctness of this calculation in existing exa ples. That of the Boyne bridge, with a uniform load of 5 tons, was $\frac{1}{9}$, with the spans shortened in effect as described.

Many other bridges of similar spans to those above name have been constructed upon the "open-side," or "truss" pri ciple, which are (in every sense of the word) *excellent* stru tures; but since no comparison of economy between them a the Victoria tubes has been offered, it would be improper class them with those (already named) which have actual been put forward as examples of economy to a large exte over the tubular system.

As an argument in favor of the trellis beams, it has bee stated that no formula has been used to value the sides of plate beam for horizontal strains; and, therefore, since th sides are thrown away except for the office they perform in co necting the top and bottom webs, it is asked why should mo material be placed in the sides than sufficient for that purpos Now I admit that there is no formula for valuing the solid sid for strains, and that we only ascribe to them the value or u of connecting the top and the bottom; yet we are aware, that, fro their continuity and solidity they, *are* of value to resist horizo tal and many other strains, independently of the top and the bo tom, by which they add very much to the stiffness of the beam and the fact of their containing more material than necessary t connect the top and bottom webs, is by no means fairly estal lished.

It is also said that the "trellis" and "Warren" beams ar usually made deeper in proportion to their span, than the tube and therefore the strain being less, a less quantity of materi is employed in the top and bottom webs. An important co sideration should be named in reply to this,—which concer all the classes of beams alluded to,—which is, that *any change o proportion in the figure of a beam changes the amount of strai caused by the load, and consequently changes the weight of th beam itself.* The resistance to horizontal strain in the abov

sses of bridges depends upon the distances between their top
l bottom webs. Such beams are said to vary in strength
ectly as their depths, and inversely as their spans. With re-
d to tubular beams, a practical rule has been established,
ich determines that the depth shall not be less than 1-15th of
span; but although this is the minimum depth given,
re is no reason to consider it the maximum depth. Indeed,
tubular bridges just named are of a greater depth than that
portion would give; for instance, the depth of Ferry bridge
1-11th of its span, and that of the Victoria tubes, next the
tre opening, is 1-12th of the span. These proportions are,
elieve, very similar to those that are actually adopted for
rren or trellis beams.

t is well known that the diagonal "struts" in these latter
tems (when under pressure) deflect as if they themselves
e beams; and any increase in the depth of the sides would
an increase of length in the diagonals; which in the "War-
" must be compensated by an increase in their sectional
a; and in the trellis beam, if they are not increased in area,
y must be in number, so as to make more intersections;
refore an increase in depth of the sides of these systems,
uld not only be a proportionate increase in their weight, but
uld be an increase per square foot of their surface. Now the
es of a tube (from their nature) may be increased in depth
to a reasonable practical limit without any increase in their
ckness.

Iaving given you my views with respect to the comparative
its of the different kinds of roadway consisting of "beams"
t may be adopted in the Victoria bridge, I now proceed to
w your attention to the adaptation of the "suspension"
nciple, similar to that of the bridge which has been complet-
within the last few months by Mr. Roebling, over the Niagara
er, near the Great "Falls."

ou are aware that during my last visit to Canada I examin-
this remarkable work, and made myself acquainted with its
eral details; since then Mr. Roebling has kindly forwarded
ne a copy of his last report, dated May, 1855, in which all
important facts connected with the structure, as well as the
ılts which have been produced since its opening for the pas-
e of railway trains, are carefully and clearly set forth.

No one can study the statements contained in that rep without admiring the great skill which has been displa throughout in the design; neither can any one who has s the locality fail to appreciate the fitness of the structure for singular combination of difficulties which are presented.

Your Engineer, Mr. Alexander Ross, has personally exami the Niagara bridge since its opening, with the view of insti ing, as far as is practicable, a comparison between that kind structure and the one proposed for the Victoria Bridge; and he has since communicated to me by letter the general con sions at which he has arrived. I think I cannot do better t convey them to you in his own words, which are subjoi below:—

"I find from various sources that considerable pains h been taken to produce an impression in England in favor Suspension Bridge in place of that we are engaged in constr ing across the St. Lawrence at this place. This idea, no do has arisen from the success of the Niagara Suspension Bri lately finished by Mr. Roebling, and now in use by the G Western Railway Company, as the connecting link betw their lines on each side the St. Lawrence, about two n below the Great 'Falls,' of the situation and particular which you will no doubt have some recollection. I visited spot lately, and found Mr. Roebling there, who gave me e facility I could desire for my objects. Of his last report on completion of the work, he also gave me a copy, which you receive with this: I have marked the points which contain substance of his statement. I also enclose an engraved sk of the structure. Mr. Roebling has succeeded in accomplis all he had undertaken, viz. safely to pass over railway trair a speed not exceeding 5 miles an hour; this speed, howeve not practised,—the time occupied in passing over 800 feet minutes, which is equal to 3 miles an hour. The deflectio found to vary from 5 to 9 inches, depending on the extent o load, and the largest load yet passed over is 326 tons of 2000 each, which caused a depression of 10 inches. A precaution been taken to diminish the span from 800 to 700 feet, by buil up, underneath the platform at each end, about 40 feet in le intervening between the towers and the face of the preci upon which they stand; and struts have also been added

ıding 10 feet further. The points involved in the considera-n of this subject are, first, *sufficiency*, and second, *cost*. ese are, in this particular case, soon disposed of. First, we ve a structure which we dare not use at a higher speed than niles an hour. In crossing the St. Lawrence at Montreal we ›uld thus occupy three quarters of an hour; and allowing sonable time for trains clearing and getting well out of each ıer's way, I consider that 20 trains in the 24 hours is the nost we could accomplish. When our communication is npleted across the St. Lawrence, there will be lines, [now sting, having their termini on the South shore,] which, with own line, will require four or five times this accommodation. s is no exaggeration. Over the bridge in question, although ned only a few weeks, and the roads yet incomplete on either , there are between 30 and 40 trains pass daily. The mixed lication of timber and iron in connection with wire, ren-s it impossible to put up so large a work to answer the poses required at Montreal; we must, therefore, construct it rely of iron, omitting all perishable materials; and we are s brought to consider the question of cost. In doing which, egards the Victoria Bridge, I find that, dividing it under e heads, it stands as follows:—

t,—the approaches and abutments, which together
ttend to 3000 feet in length, amount in the estimate
....£200,000
ond,—the masonry, forming the piers which occupy
ıe intervening space of 7000 feet between the abut-
ents, including all dams and appliances for their
ection....................................£800,000
d,—the wrought-iron tubular superstructure, 7000
et in length, which amounts to.................£400,000
(About £57 per lineal foot.)
ing a total of..............................£1,400,000

By substituting a Suspension Bridge the case would stand :—The approaches and abutments extending to 3,000 feet ngth being common to both, more especially as these are in an advanced state, may be stated as above at £200,000. The Masonry of the Victoria Bridge piers, range from 40 to eet in height averaging 56 feet and these are 24 in number,

the number required for a suspension bridge admitting of spa of about 700 feet, would be 10, and these would extend to average height of 125 feet.—These 10 piers, with the prop tions due to their height and stability, would contain as mu (probably more) masonry as is contained in the 24 piers signed for the Victoria Bridge, and the only item of savi which would arise between these, would be the *lesser* number dams that would be required for the suspension piers; but thi beg to say, is more than doubly balanced by the excess in r sonry, and the additional cost entailed in the construction, so greatly an increased a height. Next, as to the superstr ture, which in the Victoria bridge costs £57 per lineal foot Mr. Roebling in his report, states the cost of his bridge to h been $400,000, which is equal to £80,000 sterling. Estimat his towers and anchor masonry at £20,000, which I believe more than their due, we have £60,000 left for the superstr ture, which for a length of 800 feet is equal to £75 per lin foot, giving an excess of £18 per foot over the tubes, of wh we have 7,000 feet in length.—By this data, we show an ex of nearly ten per cent in the suspension, as compared with tubular principle, for the particular locality with which have to deal, besides having a structure perishable in itself account of the nature of the materials; and to construct t entirely of iron, would involve an increase in the cost wl no circumstance connected with our local, or any other, con eration at Montreal, would justify. We attain our ends b much more economical structure, and, what is of still gre consequence, a more permanent one; and as Mr. Roebling s no suspension bridge is safe without the appliances of stays f below, no stays of the kind referred to could be used in Victoria bridge,—both on account of the navigation and ice, either of which, coming in contact with them, w instantly destroy them. No security would he left against storms and hurricanes so frequently occurring in this part of world.

"No one, however, capable of forming a judgment upon subject will doubt for one moment the propriety of adopting suspended mode of structure for the particular place and ol it is designed to serve at Niagara. A gorge 800 feet in w and 240 in depth, with a foaming cataract racing at a speed

o 30 miles an hour, underneath, points out at once that the gn is most eligible ; and Mr. Roebling has succeeded in perming a work capable of passing over 10 or 12 trains an hour, should be required to do so. The end is attained by means most applicable to the circumstances; these means however only applicable where they can be used with economy, as in instance."

y own sentiments are so fully conveyed in the above extract n Mr. Ross's letter, that I can add no further remark upon subject, except that there appears to be a discrepancy in that which relates to cost.

n dividing the £80,000 into items, Mr. Ross has deducted ,000 for masonry, and left the residue £60,000 for the 800 of roadway. Now it appears evident that this amount should ude the cost of the "land chains;" and assuming their value bout £15,000, there would be only £45,000 left for the 800 of roadway, thus reducing the cost per lineal foot to about of the tube. But in the application of a suspension bridge he St. Lawrence the item £15,000 for land chains, would ourse have to be added to the cost of the 7000 feet of road-, which would swell the amount per foot to a little over that ne tubes.

n all that has been said respecting the comparative merits of different systems of roadway, you will perceive that a *com- wooden structure* has not been alluded to, because, in the place, when the design for the Victoria Bridge was at first g considered, *wood* was deemed not sufficiently permanent; ne second place, the structures alluded to in the report, as g inferior to that now in progress, are proposed to be con-cted of stone and iron work ; and as a third reason, the con-ction of the tubular roadway is already so far advanced that alteration, to the extent of abandoning *iron* and adopting *l*, must involve monetary questions of so serious a nature as nder the subject beyond discussion, or even being thought n this Report.

n conclusion, therefore, I have to state to you my deliberate ion, that the present design now being carried out for the oria Bridge is the most suitable that can be adopted, taking he circumstances into consideration, to which the question tes. In making this statement, I must ask you to bear in

mind, that I am not addressing you as an advocate for a tubul bridge, I am very desirous of calling your especial attention this fact; for really much error prevails upon this point, throu the impression that in every case I must appear as an advocat No one is more aware than I am that such inflexible advoca would amount to an absurdity.

I entirely concur in what Mr. Ross says respecting the pr priety of applying the suspension principle of the passage acro the Niagara gorge. No other system of bridge building yet d vised, could cope with the large span of 800 feet, which w there absolutely called for, irrespective of the other difficulti alluded to.

Where such spans are demanded, no design of "beam" wi which I am acquainted would be at all feasible. The tube, tre lis, and triangular systems are impracticable, in a commerci sense, and even as a practical engineering question, the diffic ties involved are all but insurmountable.

Over the St. Lawrence, we are, fortunately, not compelled adopt very large spans; none so large in fact, as have be already accomplished by the simple "girder" system. It is u der these circumstances that the suspension principle fails in n opinion to possess any decided advantage in point of expens whilst it is certainly much inferior, as regards stability for ra way purposes. The flexure of the Niagara Bridge, though real small, is sufficiently indicative of such a movement amongst t parts of the platform as cannot fail to augment where *wood* employed, before a long time elapses.

I beg that this observation may be not considered as bei made in the tone of disparagement: on the contrary, no o appreciates more than I do the skill and science displayed Mr. Roebling in overcoming the striking engineering difficulti by which he was surrounded. I only refer to the question of fle ure in the platform as an unavoidable defect in the suspensi principle, which, from the comparatively small spans that a available in the Victoria Bridge, may be entirely removed out consideration.

I am, Gentleman,

Your obedient Servant,

(Signed,) ROB. STEPHENSON

ᚿTRACT FOR CONSTRUCTION OF THE VICTORIA ꝛIDGE OVER THE RIVER ST. LAWRENCE AT MONREAL.

ɥis Deed, made the 29th day of September, in the year of our l 1853, by and between the Grand Trunk Railway Company anada, of the first part; and William Jackson, of Birkenl, and Samuel Morton Peto, Thomas Brassey, and Edward l Betts, all of London, in England, Contractors, and doing ness in Canada as Contractors, under the name and style of ckson, Peto, Brassey, & Betts," of the second part. Wherey an Act of the Parliament of the Province of Canada, passı the sixteenth year of the reign of Her Majesty Queen Vic-, and intituled, "An Act to provide for the construction of neral Railway Bridge over the River Saint Lawrence, at or ıe vicinity of the City of Montreal,' the Grand Trunk Rail-Company of Canada are authorised and empowered to conct a Railway Bridge to be called and known as "The Vic- Bridge," across the River Saint Lawrence, from some point ıe City or Parish of Montreal, above the point known as the usseau Migeon," to some point in the Parish of Saint An- de Longueuil, or in the Parish of Laprarie de la Madeline nd whereas the said Grand Trunk Railway Company of Caı have determined to avail themselves of the powers and isions in the said Act contained, and for that purpose have ed with the said parties of the second part, that they, the parties of the second part shall build and construct a Tur Bridge across the River Saint Lawrence as aforesaid, and r works connected therewith, according to the plans, sections, specifications hereinafter mentioned, and on the terms and in the time hereinafter mentioned.

nd whereas the said parties hereto of the second part (hereer called the Contractors) have agreed with the said the ıd Trunk Railway Company of Canada, that they, the said tractors, will make, build and construct the said tubular ge over the said River Saint Lawrence, at or near Montreal foresaid, and other works connected therewith as hereinafter

mentioned, according to the plans, sections, and specificatio prepared and drawn by Robert Stephenson, of London, aforesa Civil Engineer, M. P., and Alexander McKenzie Ross, of Montr Civil Engineer, and either annexed hereto, or endorsed so as refer to this Contract or Agreement upon the terms and con tions and for the price hereinafter mentioned. Now, therefo this Deed witnesseth that it is hereby agreed by and between t said the Grand Trunk Railway Company of Canada, of the fi part, and the said Contractors for themselves, their heirs, e cutors, and administrators, of the other part, in manner follo ing: that is to say, that they, the said Contractors, will ma build, construct, and complete the said Tubular bridge over River Saint Lawrence, and other works at or near Montreal first above mentioned, at such point as shall be selected there by said Robert Stephenson and Alexander McKenzie Ro with all the works necessarily or properly appurtenant there in accordance with the said plans, sections, and specificati hereunto annexed or referring hereunto by endorsement or w any subsequent alteration or modification thereof as hereinaf mentioned, and in accordance with any additional pla sections, or specifications as also hereinafter mention The Bridge when completed to be in perfect repair, and the best and most substantial character, and to be appro by said Robert Stephenson. That the Contractors shall, case the payments hereinafter stipulated for are duly and pu tually made, complete the said Tubular bridge and deliver it o to the Company ready for the laying the said Railway there within eight years from the first day of July, 1853, subject h ever, to such extension of time, if required by the Contract as the said Robert Stephenson or such other Engineer to be pointed as hereinafter mentioned, shall fix and determine. A the said Company hereby undertake to apply for and obt from the Provincial Parliament of Canada powers to extend time for the completion of the bridge, in conformity with t clause.

That the said Robert Stephenson and Alexander McKen Ross shall have the location of the Bridge, and shall select a determine the point at which the Bridge shall cross the Riv and the line or course in which it shall be made, the said sel tion and determination to be made in accordance with said A

l the provisions thereof, and that the said Robert Stephenson l Alexander McKenzie Ross shall have liberty to make such erations and modifications as they may jointly agree and think oper in all or any of the plans and sections and the specifica- ı, and may draw and prepare such further or additional plans l sections, specifications, and detail plans of construction as y may jointly agree on and think proper.

That for and in consideration of the Contract sum of £1,400,-), sterling, the Contractors take upon themselves all ordinary ks and contingencies, including that of any extra expense by son of any alteration or modification of the plans, sections, l specifications, not involving additional expenditure, and sub- t to the award of the said Robert Stephenson or such other gineer, to be appointed as hereinafter mentioned, as to whether Contractors are to be entitled to any and to what amount of ra payment up to the sum of £100,000, sterling, for any ex- ordinary circumstances or contingencies which may arise ring the progress of the works, and which the said Robert phenson or such other Engineer as aforesaid, may consider itles the Contractors to extra payment.

And the said "The Grand Trunk Railway Company of Cana- " the parties of the first part, agree and covenant with the ntracters, their executors and administrators, that for the ex- ıtion and construction by them of the same Tubular Bridge l other works, in accordance with and upon the terms and ıditions of this Agreement, and of the plans, sections, l specifications before mentioned, that they, the said "The and Trunk Railway Company of Canada," will pay the said ntractors the said price or contract sum of £1,400,000, rling, and also such additional sum not exceeding in the ole the sum of £100,000, sterling, as shall be awarded by the d Robert Stephenson or such other Engineer as aforesaid.

That the mode of payment shall be as follows :—

When and so soon as the said Robert Stephenson and Alexan- r McKenzie Ross, or either of them, shall certify that the Con- ctors have *bonâ fide* expended £50,000, sterling, in land, work, materials, or plant brought upon or near the line of the pro- sed bridge, the Company shall pay to the Contractors in cash e amount so certified, less £10 per cent, which the Company all retain in their hands as a reserve, and at the end of one

calendar month from the date of such certificate, the said Robe Stephenson and Alexander McKenzie Ross, or either of ther shall certify the value of the work done, and materials or pla brought from or near the line in such previous month, and tl Company shall pay to the Contractors in cash the amount certified, less 10 per cent, as before, and so on, at the end each successive calendar month, until the amount reserved l and retained in the hands of the Company shall amount to tl sum of £25,000, sterling, after which the whole of the amou certified shall be paid to the Contractors, without any reser whatsoever ; and upon the completion of the work and the gi ing of the final certificate of the said Robert Stephenson and Ale ander McKenzie Ross of the completion of the said Bridge, tl Company shall pay over to the Contractors in cash the amou so reserved and retained, and balance of any remaining in the hands of the said Contract sum.

That the Engineer of the Company shall, as soon as the site the Bridge is fixed, agree with the Contractors upon a Schedu in sections on which the various advances and payments on a count shall be made, which, when so agreed, shall become part of this Contract.

And it is hereby declared and agreed, that in case of the deat refusal, or inability to act of the said Alexander McKenzie Ros another Engineer shall from time to time be appointed by tl said Robert Stephenson in place of, and who shall have all tl powers of the said Alexander McKenzie Ross, and all acts, ma ters, and things which under this agreement then remained to l done by the said Robert Stephenson and Alexander McKenzie Ro shall be done by the said Robert Stephenson, and such other E gineer to be from time to time appointed by him ; and in tl event of the death, or refusal, or inability to act of the sa Robert Stephenson, then all things then remaining to be do by the said Robert Stephenson shall be done by an eminent Civ Engineer, to be appointed by the President for the time being, the institution of Civil Engineers, in England, upon the requ sition of the parties hereto, or either of them.

That if any question or difference of opinion shall arise betwee the parties hereto as to this agreement, or any matter connect therewith or arising thereout in any way, every such questic or difference of opinion, as often as any such shall arise, shall l

erred to the absolute decision of the said Robert Stephenson, sole arbitrator, or in case of his death to the decision of an inent Civil Engineer, to be from time to time appointed by President of the Institution of Civil Engineers, in England, l the decision of the said Robert Stephenson, or of such Engi-r to be so appointed, shall be binding and conclusive upon h parties as to the question or difference of opinion so re-red to him.

'hat the parties hereto will make and enter into all such ds and other instruments as may be necessary for giving ct to such reference, and will also enter into all deeds which y become necessary or expedient in fully carrying out the ie.

'hat whenever in this Contract the words "the Contractors" used they shall mean William Jackson, Samuel Morton Peto, mas Brassey, and Edward Ladd Betts, or the survivors or vivor of them, or three out of four of them, or two out of three of m, or the executors, administrators, or asisgnees of the survi-; and in the event of the bankruptcy or insolvency of any one iore of them, their or his assignees shall be excluded from all trol or interest in this Contract; and when any act is to be e by the Contractors it shall be sufficient if done by or by the iority of the majority of them, or by the majority of the sur-rs of them in person, or acting under power of Attorney i each to the other, or by the survivor or survivors of them y his executors, administrators, or assigns.

i witness whereof, the said "The Grand Trunk Railway ipany of Canada," the parties of the first part, have hereunto ed their common Seal, and the parties of the second part hereunto set their hands and affixed their Seals, the day year first herein above written.

gned, sealed, and delivered (in duplicate), in presence of

WILLIAM JACKSON, [L S.]
S. M. PETO, [L S.]
THOMAS BRASSEY, [L S.]
EDWARD L. BETTS, [L S.]

ie Seal of the Grand Trunk Railway Company of Canada, hereunto affixed by me,

JOHN ROSS,
President.

Specification referred to in foregoing Contract.

This structure, as designed, extends to a length of nine thou sand four hundred and thirty-seven feet from one extreme en to the other, and consists of twenty-five openings, spanned b wrought-iron beams, resting upon solid pieces of limestone ma sonry, and at an elevation in the centre opening (which is thre hundred and thirty feet wide) of sixty feet clear height abov the summer water level, from thence descending at the rate o one in one hundred and thirty to either end, which terminat at a level twenty-four feet below that of the centre.

The Contract comprehends the supply of all materials, th construction and completion of that portion extending from th shores of the river to the abutments of the Bridge, consistin principally of stone embankments.

The construction and completion of twenty-four piers or tow ers and two abutments of limestone masonry, and the constru tion and completion of the wrought iron superstructure, exten ing to a length of six thousand five hundred and seventy-six fee Also, the construction and completion of the permanent wa extending the whole length of the Contract.

The raising and final erection on the piers, the painting an the entire completion of all the iron, wood, and stone work d scribed in the following specifications and accompanying dra ings, together with all works incidental to snch constructi and completion, and which may not be particularly describe

All temporary erections in staging machinery, floating cra and every appliance requisite for carrying on the works in t most approved and systematic manner to be provided ; and d ring any operations connected with the execution of the worl which may impede or interfere with the navigation of the riv or which operations may be interfered with by anything passi on the river, the Contractors shall adopt all such precautio by lights and signals, or by the use of boats, hulks, booms, fenders, or by any other means for the protection of the pub using the river, or of the works of the Bridge, as shall be reas ably necessary, as also for securing the works while in progr from any injury they may at any time sustain from vessels na gating the St. Lawrence, or from storms or any other ca likely to damage the works.

And any damage or injury which may at any time be sustain- l from any cause whatever, to be at the risk of the Contractors, ho will be bound to make good the same at their own cost, ive and except such damage as may arise from tempest or any ct of God, not to be provided against by a reasonable amount f human caution.

The whole of the works herein referred to, as well as the iode of execution, is to be under the entire control, supervision nd direction, and is to be constructed to the entire satisfaction f the Engineers, who shall have full power to alter, enlarge, or iminish the forms, dimensions, positions, or quantities of any of ie works not involving extra expenditure in the whole; and during their progress any imperfection shall appear in any art of the works, it shall be immediately repaired and made good nder the direction and to the satisfaction of the Engineers.

The whole of the works of the Contract to be completed with- the period of eight years from the first day of July, one thou- ind eight hundred and fifty-three.

Approaches.—One thousand three hundred and forty-four feet t the north, and one thousand and thirty-three feet at the south id, are to be constructed of solid embankments composed of one, to the average height of thirty feet above summer water vel, and of the width of thirty feet on the upper surface, formed ith a slope of one to one on the down-stream side, and a slope f two and a half to one on the upper side,—as shown on the rawings detailing in this portion of the work.

All loose materials and debris of every description being first emoved and cleared from the surface of the rock forming the ed of the River upon which the structure is founded.

The masonry forming the approaches and abutments to the ridge erected on the above, is to be composed of Limestone shlar in large blocks.

All the beds and vertical joints to be square-dressed in the iost efficient and workmanlike manner. The external face of he masonry to be rough, and without any pick or tool marks f any kind. The natural quarry-face, in all cases, to be preserv- d, excepting in the string-courses and copings, which are to be air pick-dressed throughout, and neatly jointed and weathered here required, and a tool-draft eight inches wide on each uoin.

The masonry of the piers of the Bridge being built in eight to twelve feet depth of water, must necessarily be set by means of the diving-bell or otherwise, as directed ; for the employment of which proper means and appliances must be provided, and on a scale commensurate with the magnitude of the undertaking and the rate of progress required.

The masonry of the piers to be constructed of the form and dimensions set forth in the drawings detailing the same. When each of the piers respectively has been brought up to the surface water-level, all irregularities in the upper bed of the masonry are to be rectified, and prepared level and square for the succeeding course.

The cut-waters and the sides of the piers, to the height of thirty-two feet above summer water level, are to be dressed smooth on the face, so as to present the least obstruction to the ice or any other masses floating down the stream ; and above this level the face of the masonry is to be left rough as from the quarry, with a tool-draft eight inches wide on each quoin.

The horizontal and external vertical beds and joints, in all cases, to be smooth, dressed and truly fitted in every particular, so as to ensure the most solid and compact mass.

Dowels to be introduced wherever directed in the blocks forming the cut-water to the piers, and iron ties and holding-down bolts to be also used as may be directed, as further precaution for securing this part of the masonry.

The blocks of limestone to be of the largest dimensions obtainable in the quarries, commencing with the thickest at the foundations, and gradually diminishing as the masonry advances to the top. Recesses to be left in the piers, as shewn upon the drawings, for the purpose of facilitating the fixing of the iron superstructure. The face of the recesses to be smooth dressed, so as to present an even and uniform surface. The mortar used to be of the best hydraulic lime, and mixed in a rolling mill, with such proportion of clean, sharp sand as may be found to produce the most effective cement. The bed of the River being formed of flat bedded limestone of generally uniform surface, a secure foundation is readily obtained ; but in some instances a lift of from two to three feet may occur within the area of a Pier foundation, and in such case these inequalities are, by means of blocks of masonry filling the same, to be brought to a general uniform

vel, and each course thereafter must be of a uniform thickness roughout, and the blocks made to fit so close one to the other to insure the most perfect and secure description of masonry, which purpose every appliance in diving-bell and other apratus must be amply provided, and also superintended by ll-known experienced workmen, previously accustomed, by ictical training, to operations of the kind required. The maary of any Pier, once commenced, must be proceeded with interruptedly, until it reaches the height of thirty feet above nmer water-level, and as much more as may be deemed necesary to insure its safety throughout the winter season, when building operations must necessarily be suspended, and dur- which time all unfinished works must be protected from the ather by such precautions as are usual and proper for effect- such purpose. Any part of the Masonry suffering from nter exposure to be restored properly and made good in a isfactory manner.

Iron Work.—The superstructure of the Bridge is to be comsed of wrought-iron beams, of the form and dimensions and ious thicknesses of metal indicated upon the drawings. The es to be punched with proper machinery adapted to such purses; and the rivetting also, as far as practicable, to be permed by proper machinery, so much of the revetting as must essarily be performed by hand to be executed in the most ctive manner. All the iron to be of the best boiler-plate n capable of bearing a tensible strain of twenty tons per are inch; any plate which may be found not to come up to standard shall be rejected. All the plates shall be rolled fectly level, and all buckle removed previous to rivetting m; they shall everywhere gauge the thickness or correspond weight to the thickness specified; to be truly sheared so as orm perfect butt joints. The angle and T irons shall be rolled he section shewn in the drawings; all the rivets to be of the y best iron used for such purposes, commonly called Scrap n, and of the dimensions set forth in the drawing. All the t holes to be truly punched and correspond fairly with each er and where required to be rimered previous to rivetting. the plates to be well brushed over with a mixture of linseed l boiled oil in equal quantities; such process to take place ile the plates are hot, and after having been passed through

the roller for the last time. On no account is any plate, angle, or T iron to be used without having previously received this coat, nor are they to be used in a rusty or dirty state. Cast-iron bed plates to be provided for the friction rollers, to be furnished with wrought-iron frames and turned friction rollers, of the dimensions and forms described upon the drawings. Lintels of wrought or cast iron as may be hereafter directed, to be provided for bearing the tubes and covering the recesses in the masonry of the Piers, for facilitating the construction and lifting of the tubes. The timber, iron rails, and other fastenings required to complete the permanent way, to be provided and fixed as shewn in the drawings. Timber, wheresoever used in bedding the tubes, or in the roadway sills, is to be creosoted under pressure, after it has been converted. All the iron work of the tubes to be properly stopped and painted, inside and out, in three coats of patent white zinc paint. All surfaces that have to be rivetted in contact with each other shall be well painted before being so rivetted.

The Engineers, or any person appointed by them for the purpose, shall have free access at all times to the works where the manufacture of any of the materials required in this Contract shall be carried on, for the purpose of inspecting and properly testing, by any means he may think proper, all or any of such materials and workmanship, and the strength and quality of any manufactured parts of the work. All the materials and workmanship, as well as the mode of constructing and erecting, shall be such as the Engineers may approve of.

The drawings and specifications are intended to give a general description of the work, and to define the quantity, quality and character of the same, and the mode in which it is to be carried on and completed; but many details which may arise in the execution must unavoidably be omitted, and some be erroneously described. Further drawings and directions will from time to time be given with reference to some parts, with the object of securing the best materials and workmanship, and the most perfect construction of every part of the Bridge, to be formed and completed according to the general design above described and shewn in the drawings attached. The Contractors to provide copies of the drawings and specifications for their own use, and to set out the work and take the necessary meas

ements and levels, and to make all such working drawings d drawings of details as may be necessary for the execution of l the works ordered from general drawings and directions fur- shed originally, or from time to time by the Engineers.

Free use of the Province Lands to be given for the construc- n of the Bridge, and also for getting timber, stone, or other terials, for the works, and the full powers of the Company to put in force for the benefit of the Contractors when required.

THE LEADING DIMENSIONS OF THE BRIDGE ARE AS FOLLOWS :—

		Feet.	Inches.
—24	Openings or Spans, of 242 feet each	5,808	0
1	Centre do	330	0
2	Centre Piers, of 27 feet each	54	0
2	Large do of 25 do	50	0
2	do do, of 23 do	46	0
2	Small Piers, of 17 feet 8 inches each	35	4
2	do do of 17 do 4 do	34	8
2	do do of 17 do 0 do	34	0
2	do do of 16 do 4 do	32	8
2	do do of 16 do 0 do	32	0
2	do do of 15 do 8 do	31	4
2	do do of 15 do 0 do	30	0
2	do do of 14 do 8 do	29	4
2	do do of 14 do 4 do	28	8
2	Abutments, of 242 do 0 do	484	0
2	Approaches { 1344 do 0 do / 1033 do 0 do }	2,377	0
	Total length	9,437	0

Depth of Tube at abutments, seventeen feet, increasing to enty-two feet in the middle.

Clear height above summer water-level, sixty feet in the mid- e, falling at the rate of one in one hundred and thirty towards e ends.

The following is a portion of the Report of the English Engineers who came out to examine the Victoria Bridge, at the request of Mr. Stevenson, prior to its opening for traffic :—

MONTREAL, 17th Dec., 1859.

To the Chairman and Directors of the Grand Trunk Railway Company of Canada, London.

GENTLEMEN,—As you may be aware, the Victoria Bridge was designed to sustain practically a load of one ton per foot run of its entire length, which load, added to the weight of the tubes themselves, it was intended should cause a horizontal tensile strain of five tons per square inch, and a compressive strain of four tons per square inch ; and the load applied as a test was as near the above load as could possibly be provided. For the purpose of registering the deflections of the various tubes, a steel wire extending throughout the entire length of the bridge was strained as tightly as possible, being supported at every bearing of the tubes over pulleys with heavy weights attached, so as to keep an equal amount of tension upon it.

This steel wire formed the datum line, from which all the deflections were measured and marked on slips of card attached to vertical staves which were fixed up at various points along the tube. The train forming the testing load was sufficiently long to cover a pair of tubes from end to end, and it was first run on to one tube when observations were registered both in that tube and the adjoining empty one also, which was of course affected owing to its connection with the loaded tube.

As the effect produced was the same in all the ordinary pairs of tubes, it will only be necessary to give you the observations taken in one pair, which were as follows :—

While the load was in the first tube only, the deflection of that tube in the middle was seven-eighths of an inch, and the adjoining empty one was lifted in the middle three-eighths of an inch. The load then being placed over both tubes the deflection was the same in each, and was three-fourths of an inch in the middle ; and when the load was run on to the second tube only, the effect on the two tubes was similar to that in the first experiment.

We next tested the large central span, which is quite unconnected with any other tube, and with the load extending from

l to end, caused a deflection of one and three-eighths of an h in the middle.

n all the experiments, the tubes returned to their original ition when the weights were removed.

The result of the test applied to the whole of the 24 tubes is hly satisfactory, inasmuch as the actual deflections were siderably within the calculated deflections, for such a load, ording to formula, well known and generally made use of. therefore consider the tubes excessively strong as regards load they are designed to carry.

And we attribute this to the perfect manner in which they e been rivetted and fitted together, and the excellent quality he iron of which they are composed.

n the 330 feet (central) tube, the smallness of the deflection ery remarkable, it being but little over five-eighths of the culated deflection.

t is worthy of remark that it was a difficult matter to make a train weighing the enormous load of one ton per foot run, l it was just as much as three large engines could do to pro- it. Such a load surely never can pass through the bridge he ordinary way of traffic.

The works required yet to be done to complete the Victoria dge are, the laying about 250 lineal feet of coping on the th approach, and fixing the iron caps to 22 piers.

And we beg to say, in conclusion, that when these small mat- s are completed, we should recommend the Board of Directors the Grand Trunk Railway Company to accept the Victoria dge from the hands of Messrs. Peto, Brassey, and Betts, the tractors, as being completed, satisfactorily, and according he true spirit and meaning of the contract.

We are, gentlemen, yours, &c.,

(Signed,) J. B. BRUCE,
B. P. STOCKMAN.

REPORT OF MR. A. M. ROSS.

Having perused the foregoing report, I have much pleasure in ing, at the request of Mr. Bruce, that I was present and took t in the experiments undertaken with a view of testing the ficiency of the tubes, and that I concur in every detail as en in the report.

ALEX. M. ROSS.

A SHORT SKETCH

OF THE

LIVES OF THE CELEBRATED ENGINEERS

GEORGE AND ROBERT STEPHENSON.

The celebrated Lord Bacon has written, that biography may be said to follow, observe, and see individuals in all places, and in every instant of their lives, offering examples profitable to men in all conditions, and furnishing to the moralist matter for profound meditation.

Perhaps the history of two men connected by the nearest ties of blood, have never been recorded by the pen of a biographer affording more matter for reflection and encouragement to genius than the lives of George and Robert Stephenson; commencing with the father, who started from the lowest step of the ladder to Fame, and ending with the son, on the very pinnacle of the Temple. Their names, too, have descended to posterity—unlike the great philosopher just mentioned, and other geniuses whose lives have been clouded with some dark spots—pure and spotless, and unsullied by any transaction, the world is aware of, that would cause the reader to sigh for the weakness of humanity.

As the lives of the two Stephensons would afford matter for volumes, all, therefore, that the reader can expect in a work of this description, limited to space, is a mere outline of their biographies; the lines without the lights and shadows to make a picture.

It is well known that the father of the late Robert Stephenson was the offspring of humble but honest parents. "Honest folks were they," says a neighbour in his rough Northumbrian

ialect, "but they had little to go and come upon, and were ore haudden doun in the world." They had six children, of hom George, the second son, was born on the 9th June, 1781, a small clay-floored house in the village of Wylam, in which ived four families.

The poor man when wages were but 12s. a week, and bread t war prices, can little afford to let his children run idle, and ttle George, at an early age, was engaged to take care of a ew cows, whose owner had the right of grazing them on the aggon roads, and to close the gates after the last waggon ad passed; for this duty he received the recompence of two ence per day, As he grew in youth and his legs were long nough to straddle the furrows, we find him promoted, with doule wages, to lead the horses at the plough, and other like work n a farm.

But as the lad grew in strength he became ambitious of higher hings, and longed to become an engine man, like his father. Ie found employment in the colliery, and went through the everal grades of promotion, from picking stones out of the oals to driving the gin horse, at the rate of eight pence a day. At fourteen he was taken by his father as assistant foreman.

The boy was a hard working lad and industrious, but, with a atural bashfulness, he feared that the owner of the colliery ould think him too small for the wages, and was in trepidaion often, lest he should meet him on his rounds.

George, however, soon out-grew all fears that his size would tand in the way of his promotion. In another year he grew o be a stout bony lad, who could lift a heavier weight and fling hammer farther than any of his comrades. A laudable ambiion, however, must have been a ruling passion in his breast, for ne Saturday night when he went to receive his wages, he was old they had been raised to the full sum of 12 shillings a week. The youth's heart bounded within him; he felt that his industry nd conduct had been appreciated, and he could not help exclaimng, as he left the foreman's office, "I am a made man for life!" Another year passed away, bringing with it still further promoion. He was now employed to keep the engine in order and to uperintend its working. The steam engine soon became his et, and his leisure hours were spent in taking it apart, cleanng and putting it up again. He soon understood it thoroughly,

and was rarely obliged to summon the colliery engineer to remedy any defect.

At eighteen George Stephenson was a full grown man, having the entire charge of a steam engine, and thoroughly master of all its details of construction. Education in those days was rarely to be obtained by the working classes, and up to this date young George Stephenson had never learned to read. The youth's heart, however, yearned after knowledge. A poor schoolmaster taught a school not far from the colliery. Thither George repaired three evenings in the week, after 12 hour's hard work, and in a year, at a cost of three pence per week, he had learned to read and to write his name. To reading and writing he determined to add arithmetic. His master set him sums on his slate to be wrought out at odd moments during the day. In the evening he took back the solutions for examination, and received new problems for the next day. In a short time he mastered the first four rules of Arithmetic, and reached the magic "Rule of Three," and beyond this the humble acquirements of his teacher did not extend.

But, although engaged 12 hours daily at his engine, devoting considerable time to the improvement of his mind from the slight education he had received from the humble schoolmaster, George still found leisure for other employments of a lighter kind, and, for the time, of a more profitable nature. We read of his following the trade of St. Crispin, as well as that of a tailor, and no doubt the trifling sums thus obtained were expended in books. By night, in his humble home,—he having become a married man at the age of twenty,—he tried, as best he might, to master the principles of mechanics. Like many other self-taught mechanics, he worked at *Perpetual Motion* and of course failed. Accident, however, put him in the way of turning his mechanical skill to advantage. Coming home one night, he saw a sad scene of confusion. The cottage chimney had been on fire ; the neighbours had extinguished it by pouring down water, and the little room had been flooded. Worst of all, his fine eight-day clock stood still, the hand mutely pointing to the hour of the disaster. The mingled soot and steam had found its way within the case, and clogged and rusted the wheels and pinions. He was told that he must call

ı the watchmaker to repair the damage. No, he would do it mself and save the money.

He tried—succeeded—and the clock was soon working away ; merrily as ever. The fame of the exploit was bruited abroad, ıd before long all the dilapidated time-keepers of the neighpurhood were sent to him to be repaired.

In the third year of his marriage he met with a sad domestic reavement in the loss of his wife. She left behind her one son, ılled Robert, who afterwards became the first engineer in England, and the architect of the famous Britannia Bridge over the enai Straits, and of the more celebrated Victoria Bridge, across ıe St. Lawrence.

Soon after the death of his wife, George Stephenson was inted to Scotland to take charge of an engine at a higher rate ' wages. But his heart yearned for his old home and motherss boy, and he returned, after a year's absence, with twentyght pounds in his pocket.

He found himself sadly needed at home. His father, old obert, had been terribly scalded and rendered totally blind by ı explosion in the colliery. With filial affection he devoted ore than one half of his savings to pay his father's debts, and tablished him in a cottage near his own, and was thence forard his sole and willing stay and support. The old man lived r many years blind, but cheerful to the last, and gladdened ith the filial affection and the rising fortunes of his son.

The wars of the Great Napoleon, in which all Europe took a ırt, caused heavy taxes, high prices, and uncertain work, and 'essed hard upon the working classes. England had 700,000 ldiers under arms, and the whole country was drained of its ırdy sons. George Stephenson was drawn for the militia, and cost him the remainder of his savings to purchase a substitute. appy for the world that it was so. The humble engineman as the last man that England could afford to lose.

At last the golden opportunity came ; " there is a tide in the fairs of man, which, if taken at the flow will lead on to forne." George Stephenson seized the advantage, and his after 'e was one successful career. At the time we speak of he was irty years of age.

Close by the pit where he worked a wealthy mining Company ıd sunk a new pit and erected an engine to pump out the

water. The engine hissed and played, but there was somethin wrong. "She could not keep her jack head out of water." "Al the engine men in the neighbourhood had tried, but were clea bet." For a whole twelvemonth George Stephenson had see the smoke from the engine rising over the hill, but to every en quiry he received the same answer, "They were drowned out. He revolved the matter in his mind until he was satisfied tha he had discovered the cause of failure, and one Saturday afte noon he walked over the hill to take a look at affairs.

"Weel, George," asked his friend Kit Keppel the "sinker, "what do you mak o' her? Do you think you could do any thing to improve her?"

"Man, I could alter her and mak her draw ; in a week's tim I could send you to the bottom."

This reply having been made known in the proper quarter, fair trial was given, "and if successful," said the "viewer," "I' make you a man for life." In three days after the engine ha been taken down and the alterations made. On the fourth da it was set to work, and accomplished in two days what all th engineers in the neighbourhood could not get the engine to d in a twelvemonth.

For this he received ten pounds and a better situation. N long after, the enginewright of the "Grand Allies" died, and th "viewer," true to his promise, appointed him to the vacant po with a salary of a hundred pounds a year.

We find him after this, being in better circumstances, engage in curious mechanical contrivances. But among all his mu tifarious occupations, he lost no opportunity of carrying on h neglected education.

The son of a neighbouring farmer was well versed in arit metic and knew something of mechanics and natural histor George soon learnt from him all that he knew.

He now placed his only son at the best school in the neighbou hood, and from him the father was not ashamed to take lesson On Saturday the lad brought home books from the neighbouri library. The son inherited the talent of the father and was a ways desirous of reducing his scientific requirements to practic He invested his pocket money in half a mile of copper wire, o end of which he attached to a kite string while the other w fastened to the garden palings, where his father's pony w

ched. An opportune thunder-cloud passing, young Bob seized occasion for verifying Franklin's famous experiments by nging the wire in contact with the tail of the pony, whose nging and kicking gave evidence of the success of the young uirer.

The father scolded a little, but chuckled inwardly at this prac-l result of his son's scientific enquiries.

About this time fearful explosions of "fire-damp" were con-ntly occurring in the collieries. One day, in 1814, the deep-part of the colliery took fire. The miners were hurrying in ror to the shaft. As George Stephenson touched the bottom, shouted "Stand back! Are there six men among you who re courage to follow me? If so, come, and we will put out fire." His voice reassured the men, and they followed him. ck and mortar were at hand. In a few minutes a wall was lt up at the mouth of the burning shaft and the air excluded, which means the fire was extinguished. But several miners re suffocated in the recesses of the mines.

Can nothing be done to prevent such occurrences?" asked , as he and Stephenson were searching for the dead bodies.

I think there can," replied George.

Then the sooner you start the better," was the reply, "for price of coal-mining now is pitmen's lives."

Stephenson had for some time been engaged in making expe-ents upon coal-damp. These were now prosecuted with h zeal. In a few months he had devised his safety-lamp, and ed it in most dangerous situations. Sir Humphrey Davy pro-ed his lamp about the same time. Both lamps were identical principle, but neither inventor had any knowledge of the ors of the other. A controversy sprung up in consequence. estimonial of £2000 was presented to Davy. The northern l-owners raised half as much for Stephenson.

n the mean time the greater portion of his time was devoted he subject of steam engines and railways, the intimate con-tion between which had begun slowly to dawn upon him.

Railways of rude construction had existed for centuries in the l districts, where heavy loads had to be hauled for short dis-ces on wooden rails covered with plate iron.

Engines had been made to run on common roads. In 1811, Blakinsop of Leeds made some improvements in locomo-

tives. One of them, the "Black Billy," ran upon the Wyla[m] road, which passed the cottage in which Stephenson was born. It was a cumbrous affair, often taking six hours to go five miles, constantly getting out of order, and running off the track, so that horses had to be sent along with it to help it out of difficulty. No wonder that the workmen pronounced it a "perfect plague." No body at the time supposed that a locomotive with a smooth driving-wheel running upon a smooth rail could draw a load. It was assumed that the wheels would slip upon the rail and the machine consequently stand still. The driving-wheel was therefore fitted with teeth which worked in cogs in a rail laid by the side of the smooth rails upon which the carriage wheels ran.

George Stephenson had in the mean time been brooding over the subject of travelling engines, and declared he could make a better. He had by this time gained credit, as an ingenious machinist, and Lord Ravensworth, the proprietor of a coal mine, advanced money to enable him to make the experiment. The engine the colliery people called "Blutcher."

Blutcher was an improvement upon Black Billy, for he could draw a train at the rate of three miles an hour. Stephenson also, by experiment, satisfied himself that a smooth wheel would hold upon a smooth rail, hence the toothed wheel and cogged rail were dispensed with.

Several improvements were afterwards made by Stephenson to this engine, by which its effective power was doubled. But although the success of the locomotive was thus established, years elapsed before it was adopted on another road.

Speculative men at last turned their attention towards railways. Foremost amongst these was a Mr. Pease, a wealthy quaker, who had, with some difficulty, procured the passage of a bill for constructing the Stockton and Darlington Railway for the passage of waggons and other carriages by "men and horses *or otherwise*." This was about the year 1821.

Mr. Pease paid a visit to Killingworth to see Bluctcher, and was convinced of the engine being more economical than horses.

George Stephenson was employed by him to make a new survey of the road—for so far had his engineering studies brought him—and to construct the locomotives by which it was to be worked.

[There was not at this time in England an establishment ca-
ɔle of making a locomotive. Stephenson proposed to set up
:h a factory.

[The thousand pounds which he had received for his "Safety-
mp," and an equal sum furnished by Mr. Pease, sufficed to
up the "Newcastle Engine Factory."

[The Stockton and Darlington road was soon opened for traffic,
l on this occasion one of Stephenson's locomotives drew a
in weighing 90 tons, 8¾ miles in 65 minutes. Thus far it
s a decided success, though on a limited scale. But a new
uggle and decided victory were in store for him.

For years the want of adequate communication between Man-
ster and Liverpool had been severely felt. Trade had out-
wn the capacity of canals. It required more time to convey
ale of cotton from Liverpool to Manchester than now from
w York to Liverpool.

The Manchester spindles stood still for want of the cotton
ich was piled up in the Liverpool warehouses. At length,
ne bold speculator suggested that railways could carry cotton
l cloths as well as coals. So a plan was formed for a rail-
y between Manchester and Liverpool; and the preliminary
veys were made, in spite of the determined opposition of the
ıal proprietors, and of the fox-hunting squires. The rural squires
re told that the engines would kill pheasants and frighten
es, so there would be an end of shooting and hunting. Farm-
were assured that cows would not graze nor hens lay near a
lroad; and timid old ladies were warned that their houses
uld be burned down by the sparks, and themselves poisoned
the pestilential smoke from the engines.

n fact, the country people of England were in as great dis-
y as a late M. P. P. of Canada, who solemnly declared in the
use of Assembly, that the engines of the Grand Trunk Rail-
y would frighten away all the milk from the cows. Every
position that could possibly be offered to the construction of
lroads in England was brought to bear against the scheme.
orge Stephenson was summoned before the committee of the
use of Commons, and a dead set made against him by the
yers. He was asked all sorts of relevant and irrelevant
stions. Would any railroad bear a train of *forty tons* moving
lve miles an hour? Had he ever witnessed such a velocity?

Would not rails bend? Would not trains turn off the track Would they not overturn when rounding a corner? If an e gine going at the rate of twelve miles an hour should encount a stray cow, wouldn't it be awkward? "Very awkward f the *coo*," replied Stephenson.

The philippics of Demosthenes or the orations of Cicero we naught compared with the eloquence brought to bear again railways; and more money was spent in lawsuits, in consequen than would have built the whole line from London to Liverpo

Even the famous Dr. Lardner, who subsequently immortaliz himself by mathematically demonstrating that the Atlant could never be profitably crossed by steam, brought his pond rous science to war against what he styled the "destruction atmospheric air."

But the bill nevertheless passed, and the road was rapid urged forward under the charge of George Stephenson, who w appointed chief engineer.

When the road was far advanced, a question arose whether should be worked by stationary engines or by locomotiv Every scientific engineer was in favor of the former. Vallan affirmed that locomotives could never draw as fast as hors Tredgold was sure that stationary engines would be safer a cheaper. Two distinguished engineers were deputed to lo into the question. They did so, and reported that stationa engines would be in every way best.

Stephenson stood alone in favor of locomotives. He saw th railways and locomotives were inseparable parts of one gr system. They were, as he phrased it, "husband and wife." He sought the directors at least to give the locomotives a fair trial fore embarking in the cumbrous stationary system, and pledg himself to construct an engine which should meet all reasonal requirements. The main conditions were that the engine shou not weigh more than six tons, and should be able to draw load of twenty tons, ten miles an hour. A prize was offered any party who should construct the best engine subject to th conditions. Stephenson's famous "Rocket" alone fulfilled conditions. It was first: the rest were nowhere. It attained average speed of fifteen miles an hour, and at times gained hitherto unheard of velocity of twenty-nine miles. His hon friend Cropper, who had advocated the stationary system, w

ounded. "Now," he exclaimed, lifting up his hands,—"now George Stephenson at last delivered."

The great battle had indeed been won by George Stephen-n. The railway system had been inaugurated; a new imple-nt had been put into the hands of civilization, the mightiest had received since the invention of printing.

Here ends the epic interest of a life which was happy and sperous to its close. He had attained well-deserved honors d fortune; and, finally, as age gathered around him, retired cefully from active life, to that serene quiet which befits a man ose life's task has been worthily accomplished. Like many at men of science and literature, he was particularly fond of nb animals, and took especial delight in his garden and con-vatory. Nor was he indifferent to old pursuits. He was ever dy to lend a helping hand to inventors who deserved assis-ce. His heart was benevolent, and his purse was open to his fellow-workmen whom age had left, as youth found them, in verty.

He died on the 12th August, 1848, in the sixty-seventh year of age.

THE LATE ROBERT STEPHENSON.

The early history of Robert Stephenson is intimately blended h that of his father, whom he ably assisted in the elaborate culations which were necessary for his purposes. Indeed, ough life the old man was accustomed to refer to his son for subtle theoretical elucidation he might want, as well as for rary help on important occasions when he had to put his ws on paper. But our space will not permit of our entering the details of the life of this truly great man.

Robert Stephenson was born at Willington, Northumber-d, on the 16th of November, 1803. His father, who had felt want of an early education, resolved that his son should not fer from the same cause, and accordingly, though at the time could ill afford it, sent him to the school at Long Benton, and 1814 placed him with Mr. Bruce at Newcastle. Robert soon played a decided inclination for mechanics and science; and, oming a member of the Newcastle Literary and Philosophical

Institution, was enabled to take advantage of its library ; so that as the Saturday afternoons were spent with his father, the volume which he invariably took home with him, formed the subject of mutual instruction to father and son. Robert's assiduity attracted the attention of the Rev. Wm. Turner, one of the secretaries to the institution, who readily assisted him in his studies and was, also, of much service to his father, with whom he soon after became acquainted. Under Mr. Bruce, Robert acquired the rudiments of a sound practical education, and, under his father's direction, was always ready to turn his acquirements to account. There still exists in the wall over the door of the cottage at Killingworth a sundial of their joint production, of which the father was always proud.

In 1818 Robert was taken from school and apprenticed to Mr .Nicholas Wood as acoal-viewer, a cting as under-viewer ; and he made himself thoroughly acquainted with the machinery and the processes of coal-mining. In 1820, however, his father being now somewhat richer, he was sent to Edinburgh University for a single session, where he attended the lectures of Dr. Hope on chemistry, those of Sir John Leslie on natural philosophy, and those of Professor Jamieson on geology and mineralogy. He returned home in the summer of 1821, having gained a mathematical prize, and acquired the most important knowledge of how best to proceed in his self-education. In 1822 he was apprenticed to his father, who had then commenced his locomotive manufactory at Newcastle, but, after two years' strict attention to the business, finding his health failing, he accepted, in 1824, a commission to examine the gold and silver mines of South America ; whence he was recalled by his father when the Liverpool and Manchester Railway was in progress, and he reached home in December, 1827. He took an active part in the discussion as to the use of locomotives on the line, and, in conjunction with Mr. Joseph Locke, wrote an able pamphlet on the subject. He also greatly assisted his father in the construction of the successful engine, which was entered in his name, though he himself ascribed the merit entirely to his father and Mr. Henry Booth, on whose suggestion the multitubular boiler was adopted.

Robert Stephenson's next employment was the execution of a branch from the Liverpool and Manchester Railway, near Warrington, now forming a portion of the Grand Junction Railway

tween Birmingham and Liverpool. Before this branch was mpleted, he undertook the survey, and afterwards the con-uction, of the Leicester and Swannington Railway; and on completion of that work he commenced the survey of the e of the London and Birmingham Railway, of which he was imately appointed engineer, and removed to London. Under direction the first turf was cut at Chalk Farm on June 1, 34, and the line was opened on Sept. 15, 1838. Fully aware the vital importance of obtaining good means of rapid transit, still continued to devote much of his time to improvements the locomotive engine, which were from time to time carried t under his direction at the manufactory in Newcastle, which some years was exclusively devoted to engines of that class, d still supplies a larger number than any other factory in the gdom, independently of many marine and stationary engines. s engagements on different lines of railway afterwards became y numerous; but he was more remarkable for the magnificent aceptions and the vastness of some of his successfully executed ojects, such as the High-level Bridge over the Tyne at New-stle, the viaduct (supposed to be the largest in the world) over Tweed valley at Berwick, and the Britannia tubular bridge er the Menai Straits,—a form of bridge of which there had been viously no example, and to which, considering its length and enormous weight it would have to sustain, the objections and difficulties seemed almost insuperable .With the assistance, wever, of Professor Hodgkinson, Mr. Edward Clark, and Mr. irbairn, in experiments on the best forms of the various tions of the structure, the difficulties were triumphantly over-ne, and in less than four years the bridge was opened to the blic, on March, 18, 1850.

Robert Stephenson was also employed in the construction of ny foreign railways. He was consulted, with his father, as to Belgian lines; also for a line in Norway between Christiania d Lake Miosen, for which he received the Grand Cross of the ler of St. Olaf from the King of Sweden; and, also, for one ween Florence and Leghorn, about 60 miles in length. He ited Switzerland for the purpose of giving his opinions as to best system of railway communication. He designed and astructed, for the Grand Trunk Railway of Canada, the Vic-ia tubular bridge over the St. Lawrence, near Montreal, on

the model of that over the Menai Straits. It is not long since h
completed the railway between Alexandria and Cairo, a distanc
of one hundred and forty miles. On this line there are two tu
bular bridges,—one over the Damietta branch of the Nile, an
the other over the large canal near Besket-al-Saba. The peculi
arity of the structure is that the trains run on the outside upo
the top of the tube, instead of inside. He was constructing a
immense bridge across the Nile at Kaffre Azzayat, to replace th
present steam-ferry, which was found to interfere too muc
with the rapid transit of passengers.

In addition to his railway labours, Robert Stephenson took
general interest in public affairs and in scientific investigations
In 1847 he was returned as member of Parliament in the Conser
vative interest, for Whitby, in Yorkshire, for which place he con
tinued to sit until his death. He acted with great liberality t
the Newcastle Literary and Philosophical Society, paying off i
1855 a debt amounting to £3000, in gratitude, as he expresse
it, for the benefits he derived in early life from that establishment
and to enable it to be as practically useful to other young men
He most liberally placed at the disposal of Mr. Piazzi Smyth hi
yacht and crew to facilitate the interesting investigations under
taken by that gentleman at the Island of Teneriffe, and ver
valuable results have been obtained. He was an honorary bu
active member of the London Sanitary and Sewerage Commis
sions; a Fellow of the Royal Society; a member of the Institu
tion of Civil Engineers since 1830, of which institution he wa
member of council during the years 1845 to 1847, vice-presiden
during those from 1848 to 1855, and president during the year
1856 and 1857. He received a gold medal of honour from th
French Exposition d'Industrie of 1855, and is said to have de
clined an offer of knighthood in Great Britain. He was also th
author of a work "On the Locomotive Steam-engine," an
another "On the Atmospheric Railway System," published i
4to. by Weale.

Mr. Stephenson left no family behind him. His wife (th
daughter of Mr. Sanderson, insurance-broker, of Old Broad
street) died many years ago, and he remained a widower.

Robert Stephenson was beloved by all who knew him. H
was a most generous man, without a particle of meaness i
his nature. He was generous to his contemporaries and asso

ıtes, and kind and forbearing to those who were under him. ; was withal modest and retiring, avoiding ovations where he uld, and shunning publicity. Above all, he was an honest ın. What was said of his father might with equal truth be ıd of him,—" He was one of nature's gentlemen."

The remains of this distinguished engineer were laid by the ːe of Telford in the nave of Westminster Abbey. The obsequies ıy be said to have approached to the character of a public ıeral, from the spontaneity, numbers, and influence of the ›urners.

An immense crowd had assembled around the precincts of the ›bey, where the hearse arrived at twelve o'clock. A procession ıs then formed into the Abbey, led by the High Bailiff of Westnster, whose silver staff of office was draped by a black scarf. e singing-boys folowed, their college caps draped in mourning. e singing-men wore black scarfs over their surplices. Then ıme the senior Canons, and afterwards Canons Jennings, Cure-ı, and Repton. The Dean of Westminster and the Very Rev. ıenevix Trench, D.D., followed; and then came the Mayor and ; Sheriff of Newcastle-upon-Tyne, in their scarlet robes. The ffin was of highly-polished oak, profusely ornamented by gilt ils, escutcheons, &c., and covered by a heavy silk pall. The ll-bearers on one side were the Marquis of Chandos, chairman of ; London and North-Western Railway; Sir Roderick Murchi-ı, F.R.S., President of the Royal Geographical Society; and '. George Carr Glyn, M.P., first chairman of the London and rth-Western Railway. The pall-bearers on the other side were . Joseph Locke, M.P.; Mr. Beale, M.P., chairman of the Midıd Railway; and Mr. George Rennie, C.E. Mr. Stephenson, ; nephew of the deceased and his nearest male relative, folved as chief mourner, and to him succeeded a long train of ›urners, in hatbands and scarfs, comprising the names best own in the railway and engineering world. The great wes-'n door of Westminster Abbey is never open except at the ıeral of persons of Royal blood, or of those to whom the nation s decreed the honours of a public funeral. The procession, wever, went from the door in the south aisle to the western or, and then directed itself along the whole length of the nave the choir. The choir commenced by singing " I am the Resur-ːtion and the Life" (Purcell), and, thus chanting, the proces-

sion passed within the screen to the choir, where the corpse for a short time was deposited. The sentences, "I know that my Redeemer liveth," and "We brought nothing into this world," were also chanted by the choir, accompanied by the organ. The 90th Psalm was then chanted to one of Purcell's chants. The Rev. Mr. Hayden, Precentor, then read the lesson, "Now is Christ risen from the dead;" after which the choir sang Handel's funeral anthem, "Where the ear heard him." The procession then re-formed, and returned to the grave; the clergy and choristers forming on the west, and the mourners on the south side. Several ladies belonging to Mr. Stephenson's family, in deep mourning, now joined the mourners. The choir hereupon sang the affecting passage, "Man that is born of woman." The dull sound of earth thrown upon the coffin was then heard, and the Dean uttered the impressive words, "Forasmuch as it hath pleased Almighty God to take unto himself the soul of our dear brother here departed, we commit his body to the ground; earth to earth, ashes to ashes, dust to dust."

The choir then sang with great sweetness, "Blessed are the dead which die in the Lord, for they rest from their labours," and Handel's beautiful anthem, "His body is buried in peace, but his spirit liveth for evermore." The Dean read the prayer, "We give Thee hearty thanks for that it hath pleased Thee to deliver this our brother out of this sinful world," and the service concluded with the Dead March in Saul by the organ.

The chief mourners then mounted the platform of earth and looked down into the shallow grave in which all that is mortal of Robert Stephenson reposes. The coffin bore the inscription, "Robert Stephenson, M.P., civil engineer, D.C.L. and F.R.S., born on the 16th of November, 1803; died on the 12th of October, 1859." The coffin of Mr. Telford was distinctly visible; and thus the two engineers who have spanned the Menai Straits, the one by the road and the other by the rail, slept side by side.

On the day of the funeral, the ships in the Thames lowered their flags in token of respect for the deceased; and at Gateshead, Newcastle, Shields, Sunderland, and Whitby, most of the places of business were closed in the afternoon. The ships carried their flags half-mast high, and muffled peals of bells rang from the church belfries.

GRAND TRUNK RAILWAY OF CANADA

TABLE OF DISTANCES.

☞ OBSERVE.—The Trains between Montreal, Toronto and Quebec, are run by Montreal time; those between Toronto, London, and Sarnia, by Toronto time; and those between Portland and Island Pond, by Portland time.

MAIN LINE.

UP TRAINS.		DOWN TRAINS.	
Total Miles.	STATIONS.	Total Miles.	STATIONS.
	MONTREAL		DETROIT
15	Pointe Claire	3	Detroit Junction
21	St. Anne's	20	Utica Plank
24	Vaudreuil	25	Mount Clemens
37	Coteau Landing	41	Beebe's Corner
54	Lancaster	62	Port Huron
60	Summerstown	63	Sarnia, Pt. Edward
68	Cornwall	94	Widder
77	Dickinson's Landing	111	Craigs
84	Aultsville	118	Lucan
92	Williamsburg		
99	Matilda	154	London
104	Edwardsburg	144	Thorndale
112	Prescott Junction		
113	Prescott	133	St. Mary's
125	Brockville	143	Stratford
129	Lyn	149	Shakespeare
137	Mallorytown	156	Hamburg
146	Lansdowne	159	Baden
155	Gananoque	162	Petersburgh
173	Kingston	168	Berlin
199	Napanee	173	Breslau
207	Tyendinaga	182	Guelph
213	Shannonville	190	Rockwood
220	Belleville	196	Acton
232	Trenton	202	Georgetown
242	Brighton	205	Norval
249	Colborne	210	Brampton
256	Grafton	216	Malton
263	Cobourg	223	Weston
271	Pope Hope	226½	Carlton
280	Newtonville	232	TORONTO
286	Newcastle		
290	Bowmanville		Don

MAIN LINE.—*Continued.*

UP TRAINS.

Oshawa
Port Whitby
Duffin's Creek
Frenchman'sBay
Port Union
Scarboro'
Don
TORONTO
Carlton
Weston
Malton
Brampton
Norval
Georgetown
Acton West
Rockwood
Guelph
Breslau
Berlin
Petersburgh
Baden
Hamburgh
Shakespeare
Stratford
St. Marys
Thorndale
London
Lucan
Craigs
Widder
Sarnia
Port Huron
Beebe's Corner
Mt. Clemens
Utica Plank
Detroit Junction
DETROIT

DOWN TRAINS.

243	Scarboro'
249	Port Union
253	Frenchman's Bay
255	Duffin's Creek.
261	Port Whitby
265	Oshawa
275	Bowmanville
279	Newcastle
285	Newtonville
294	Port Hope
302	Cobourg
309	Grafton
316	Colborne
323	Brighton
334	Trenton
345	Belleville
352	Shannonville
358	Tyendinaga
366	Napanee
392	Kingston
410	Gananoque
419	Lansdowne
428	Mallorytown
436	Lyn
440	Brockville
452	Prescott
453	Prescott Junction
461	Edwardsburg
466	Matilda
473	Williamsburg
481	Aultsville
488	Dickinson's Landing
497	Cornwall
505	Summerstown
511	Lancaster
531	Coteau Landing
541	Vaudreuil
544	St. Anne's
550	Pointe Claire
565	MONTREAL

FRESHMENT ROOMS at Point St. Charles, Cornwall, Kingston, Cobourg, St. Mary's and Sarnia.

MAIN LINE.—*Continued.*

DOWN TRAINS.		UP TRAINS.	
Distances in Miles.	STATIONS.	Distances in Miles.	STATIONS.
	Montreal		Portland
3	St. Lambert	5	Falmouth
18	St. Hilaire	11	Yarmouth
31	St. Hyacinthe	12	Yarmouth Junction
38	Britannia Mills	22	New Gloster
44	Upton	28	Danville Junction
50	Acton	37	Mechanic Falls
62	Durham	41	Oxford
73	Richmond	48	South Paris
83	Windsor	62	Bryant's Pond
91	Brompton Falls	70	Bethel
97	Sherbrooke	80	Giead
100	Lennoxville	85	Shelburne
107	Waterville	91	Gorham
111	Compton	97	Berlin Falls
119	Coaticook	103	Milan
127	Boundary Line	109	West Milan
144	Island Pond	122	Northumberland
159	North Stratford	134	North Stratford
171	Northumberland	149	Island Pond
184	West Milan	166	Boundary Line
190	Milan	174	Coaticook
195	Berlin Falls	182	Compton
202	Gorham	186	Waterville
208	Shelburne	193	Lennoxville
213	Gilead	196	Sherbrooke
223	Bethel	202	Brompton Falls
231	Bryant's Pond	210	Windsor
245	South Paris	221	Richmond
252	Oxford	231	Durham
257	Mechanic Falls	243	Acton
265	Danville Junction	249	Upton
271	New Gloster	255	Britannia Mills
281	Yarmouth Junction	262	St. Hyacinthe
282	Yarmouth	275	St. Hilaire
288	Falmouth	290	St. Lambert
293	Portland	293	Montreal

MAIN LINE.—*Continued.*

QUEBEC AND RICHMOND DISTRICT.

)OWN TRAINS. UP TRAINS.

l .	STATIONS.	Total Miles.	STATIONS.
	Montreal		Point Levi
	Richmond	8	Chaudiere Junction
	Danville	9	Chaudiere
	Warwick	15	Craig's Road
	Arthabaska	20	Black River
	Stanfold	29	Methot's Mills
	Somerset	41	Becancour
	Becancour	49	Somerset
	Methots Mills	55	Stanfold
	Black River	64	Arthabaska
	Craig's Road	72	Warwick
	Chaudiere	84	Danville
	Chaudiere Junction	96	Richmond
	Point Levi	169	Montreal

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e West at 8·15 A.M. and 6.00 P.M.
e allowed for Rrefreshments at Richmond.

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m n to on.	Total Miles.	STATIONS.	From Station to Station.	Total Miles.	STATIONS.
		Point Levi			St. Paschal
	17	St. Henry	10	10	R. Ouelle
	25	St. Charles	7	23	St. Rochs
	49	St. Thomas	39	39	L'Islet
	63	L'Islet	14	53	St. Thomas
	79	St. Rochs	23	76	St. Charles
	92	R. Ouelle	9	84	St. Henry
	101	St. Paschal	8	101	Point Levi

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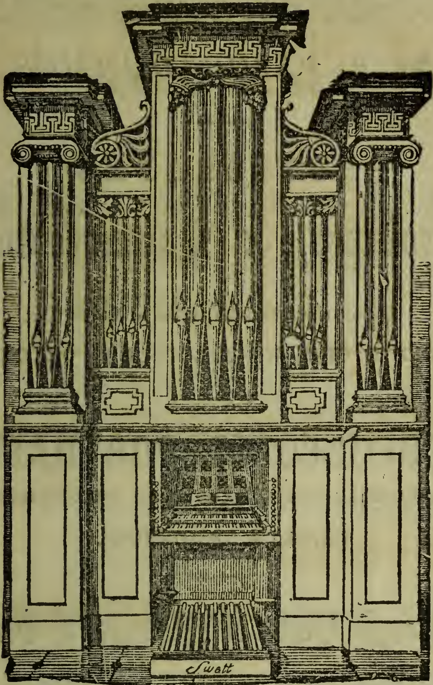

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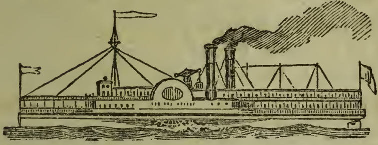

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